Materials & Methods

THE MAGAZINE OF

MATERIALS ENGINEERING

DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

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JANUARY 1952

How to Select Steels for Low Temperature Service

Aluminum Alloy Die Castings in Complex Automotive Parts

Silicone Coatings Protect Metals in Severe Service

How to Choose Spring Materials

Rocket Parts Heat Treated in Mechanized Salt Bath

Materials at Work: Nickel Alloys in Gas Turbine

Induction Descaling of Steel

New Lithium Ceramics

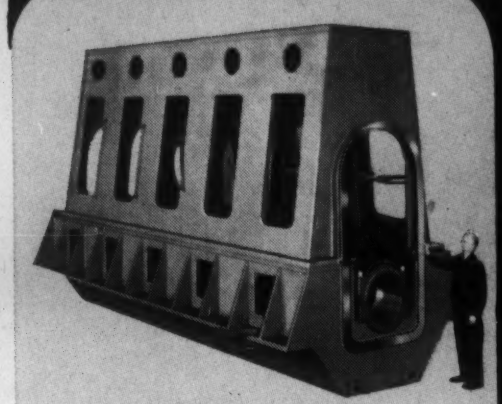
Fluids for Hydraulic Systems

Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite, Stainless Steels

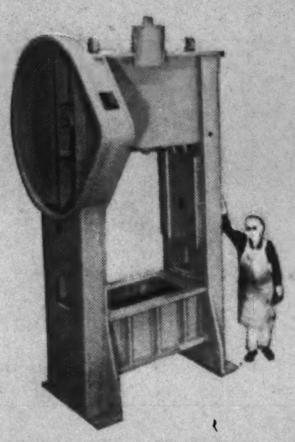
Materials & Methods Manual No. 78

REVIEW OF MATERIALS ENGINEERING DEVELOPMENTS IN 1951

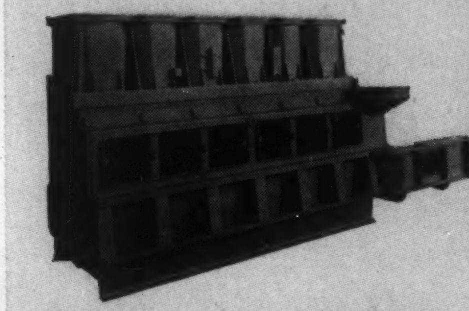
Steel-Weld FABRICATION



Crank Cases Frames and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type

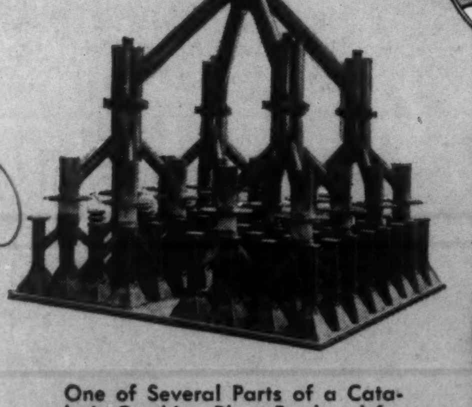


Heavy Press and Machine Frames and Bases for the Machine Tool Industry



Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field

Pressure Vessels for the Chemical and Allied Industries.



One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

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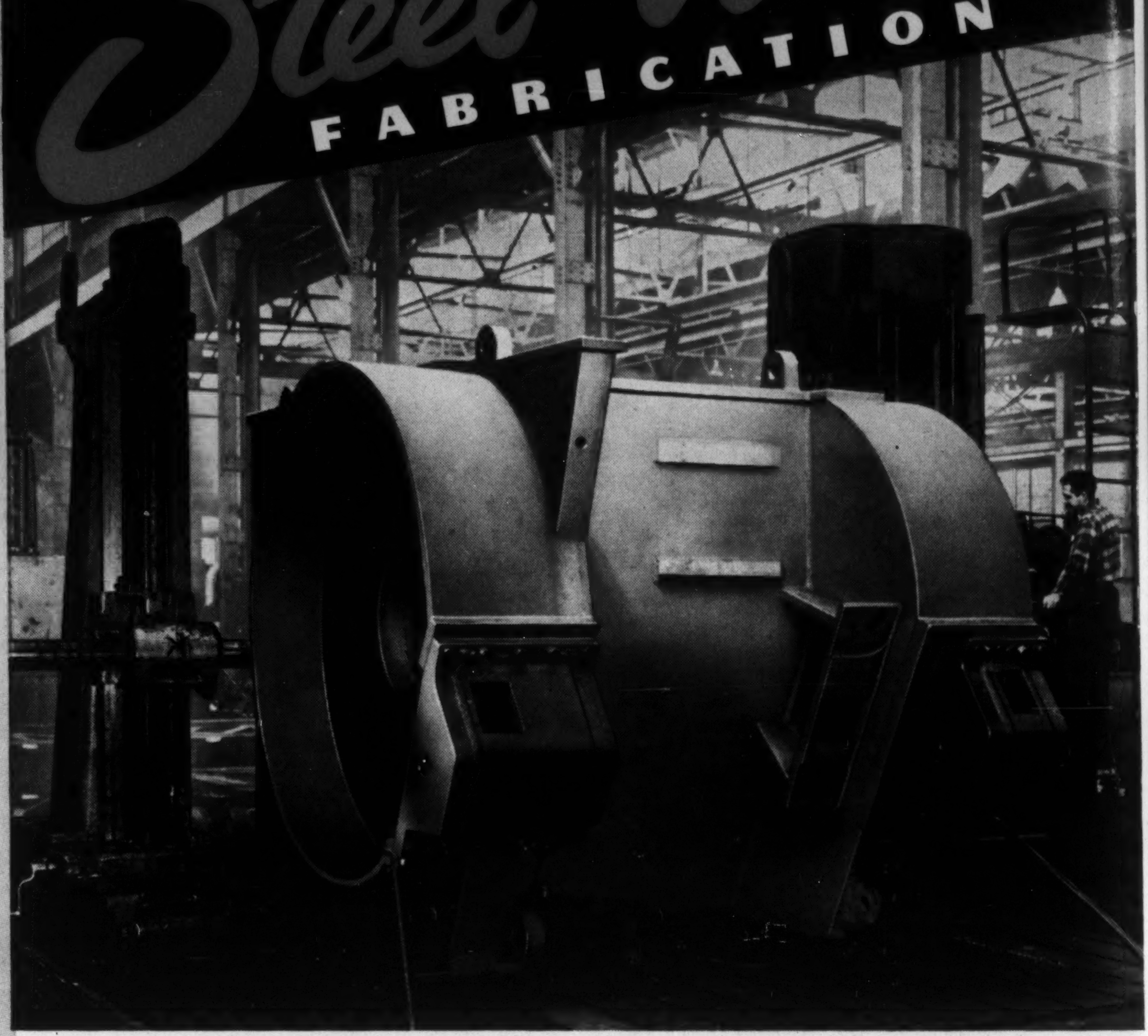

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Index of Feature Material

MATERIALS & METHODS

Volume 35, January-June 1952, inclusive

Feature editorial matter for Volume 35 of MATERIALS & METHODS covering issues from January through June 1952 is indexed here. Material covered in the index includes feature articles, MATERIALS & METHODS Manuals, and Engineering File Facts.

Aluminum and its Alloys
- Aluminum Alloy Die Castings Used in Complex Automotive Parts—Jan., p 80
- Aluminum Photographic Process Has Industrial Applications—Apr., p 176
- Copper-Clad Aluminum Can Conserve Copper in Many Uses—Feb., p 82
- Electroplated Coatings on the Light Metals (MATERIALS & METHODS Manual)—June, p 119
- Interleaving Paper for Aluminum Inhibits Water Stain, New—Feb., p 176
- Protective Treatment for Aluminum Simplifies Processing at Reduced Costs, New—Feb., p 91
- Soldering Aluminum, Materials and Procedures for—Apr., p 116

Aluminum Alloy Die Castings Used in Complex Automotive Parts—Jan., p 80
Aluminum Photographic Process Has Industrial Applications—Apr., p 176
Automatic Blow Molding, Thin Hollow Plastic Shapes Produced by—Feb., p 88
Beryllium-Copper Useful for Large Machine Parts—June, p 97
Black Oxide Finish Produced on Steel by Chemical Dip Method, Low Cost—Mar., p 92
Boron Steel, Hardenability as the Criterion for Selecting—Mar., p 84
Boron Steel, Tentative Hardenability Bands for New—Mar., p 123
Boron Treated Types of Alternate Steels (File Fact)—Feb., p 127

Brazing (see Welding)
- Brazing and Soldering Materials, How to Select (MATERIALS & METHODS Manual)—Mar., p 105

Carbon Graphite Materials and Parts (MATERIALS & METHODS Manual)—Apr., p 119

Castings and Casting
- Aluminum Alloy Die Castings Used in Complex Automotive Parts—Jan., p 80
- Continuous Casting, Better Brass Mill Products Produced by—Apr., p 94
- Machinability of Thin Gray Iron Castings, How Structure Influences—Feb., p 99

Casting Resin Used for Low Cost Forming Tools, New—May, p 105
Cellular Rubber Insulates, Seals and Cushions—Apr., p 91
Chromium-Vanadium Steels (File Fact)—Apr., p 139

Cleaning and Finishing
- Induction Descaling Proves a Fast, Economical Method for Cleaning Steel—Jan., p 97
- Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
- Wet Blasting Performs Many Cleaning and Finishing Operations—Apr., p 98

Coatings and Finishes
- Black Oxide Finish Produced on Steel by Chemical Dip Method, Low Cost—Mar., p 92
- Porcelain and Ceramic Coatings, New Developments in—May, p 87
- Pre-Plated Drawn Steel Wire Saves Scarce Metals—May, p 96
- Protective Treatment for Aluminum Simplifies Processing at Reduced Costs, New—Feb., p 91
- Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
- Silicon Coatings Protect Metals Against Severe Service Conditions—Jan., p 82

Continuous Casting, Better Brass Mill Products Produced by—Apr., p 94

Copper, Brass and Bronze
- Beryllium-Copper Useful for Large Machine Parts—June, p 97
- Continuous Casting, Better Brass Mill Products Produced by—Apr., p 94
- Copper-Clad Aluminum Can Conserve Copper in Many Uses—Feb., p 82
- Drawing Brass Cuts Finishing Costs, New—Mar., p 82
- Pre-Plated Drawn Steel Wire Saves Scarce Metals—May, p 96
- Spring Materials, How to Choose (Part II)—May, p 112

Copper-Clad Aluminum Can Conserve Copper in Many Uses—Feb., p 82

Corrosion
- Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 and Type 316 Stainless Steel (File Fact)—Jan., p 115
- Salt Spray Tests, A Critical Look at—Feb., p 77
- Salt Spray Tests, A Critical Look at (Discussion)—Mar., p 77

Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 and Type 316 Stainless Steel (File Fact)—Jan., p 115
Drawing Brass Cuts Finishing Costs, New—Mar., p 82
Electroplated Coatings on the Light Metals (MATERIALS & METHODS Manual)—June, p 119

Engineering File Facts
- Boron Treated Types of Alternate Steels—Feb., p 127
- Chromium-Vanadium Steels—Apr., p 139
- Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 Type 316 Stainless Steel—Jan., p 115
- Natural and Synthetic Rubbers, Relative Properties of—Apr., p 137
- Precious Metals, Properties of—May, p 133
- Price-Volume Ratios for Plastics and Metals—June, p 137
- Stainless Steels, Relative Workability of—June, p 135
- Steel Compositions to Conserve Critical Alloying Elements, New—Mar., p 121

European Research on the Behavior of Metals Yields Promising Results—June, p 93

Fabricated Forms and Parts
- Aluminum Alloy Die Castings Used in Complex Automotive Parts—Jan., p 80
- Beryllium-Copper Useful for Large Machine Parts—June, p 97
- Carbon Graphite Materials and Parts (MATERIALS & METHODS Manual)—Apr., p 119
- Cellular Rubber Insulates, Seals and Cushions—Apr., p 91
- Fluorocarbon Plastics Bonded to Metals and Rubbers to Provide New Composite Materials—Mar., p 96
- Metal Powder Parts, The Plus and Minus of Making Your Own—Apr., p 101
- Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
- Spring Materials, How to Choose (Part I)—Jan., p 85
- Spring Materials, How to Choose (Part II) May, p 112

Fluids for Hydraulic Systems—Jan., p 100
Fluorocarbon Plastics Bonded to Metals and Rubbers to Provide New Composite Materials—Mar., p 96

Forming
- Drawing Brass Cuts Finishing Costs, New—Mar., p 82
- Intricate Forming of Glass Accomplished by New Photochemical Method—May, p 94
- Stainless Steels, Relative Workability of (File Fact)—June, p 135

Gold Scrap Recovery Methods Applicable to Scarce and Costly Materials—Mar., p 102
Harden Small Steel Parts, How to—Apr., p 112

Heating and Heat Treatment
- Boron Steels, Hardenability as the Criterion for Selecting—Mar., p 84
- Boron Steel, Tentative Hardenability Bands for New—Mar., p 123
- Harden Small Steel Parts, How to—Apr., p 112
- Heat Treating of Connecting Rods, Production—June, p 100
- Induction Descaling Proves a Fast, Economical Method for Cleaning Steel—Jan., p 97
- Nitriding, How to Case Harden Steel by—May, p 90
- Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
- Rocket Parts Effectively Heat Treated in Mechanized Salt Bath Furnace—Jan., p 90

Heat Treating of Connecting Rods, Production—June, p 100
High Temperature Fastening Problem Solved with Special Self-Locking Nuts—June, p 109
Induction Descaling Proves a Fast, Economical Method for Cleaning Steel—Jan., p 97
Inert-Gas-Shielded Metal Arc Process, Carbon Steel Successfully Welded by—Feb., p 86
Interleaving Paper for Aluminum Inhibits Water Stain, New—Feb., p 176
Intricate Forming of Glass Accomplished by New Photochemical Method—May, p 94

Irons
- Machinability of Thin Gray Iron Castings, How Structure Influences—Feb., p 99
- Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103

Lithium Ceramics, New—Jan., p 98
Machinability of Thin Gray Iron Castings, How Structure Influences—Feb., p 99

Machining and Machined Parts
- Machinability of Thin Gray Iron Castings, How Structure Influences—Feb., p 99
- Trepanning Speeds Boring Holes in Heavy Metal Sections—May, p 174

Magnesium
- Electroplated Coatings on the Light Metals (MATERIALS & METHODS Manual)—June, p 119

Manuals, Materials & Methods
- Brazing and Soldering Materials, How to Select—Mar., p 105
- Carbon Graphite Materials and Parts—Apr., p 119
- Electroplated Coatings on the Light Metals—June, p 119
- Plastics as Alternate Materials—Feb., p 101
- Review of Materials Engineering Developments in 1951—Jan., p 103
- Titanium and its Alloys—May, p 117

Materials Engineering Department at Westinghouse Develops, Improves and Applies Materials—Apr., p 86
Metal Powder Parts, The Plus and Minus of Making Your Own—Apr., p 101
Mica Paper Developed for Electrical Insulation—June, p 174
Natural and Synthetic Rubbers, Relative Properties of (File Fact)—Apr., p 137
Needle Tubing Extended to Mechanical Applications—June, p 106

Nickel and its Alloys
- Pre-Plated Drawn Steel Wire Saves Scarce Metals—May, p 96
- Spring Materials, How to Choose (Part II)—May, p 112
- Nitriding, How to Case Harden Steel by—May, p 90

Noble Metals
- Gold Scrap Recovery Methods Applicable to Scarce and Costly Materials—Mar., p 102

over

(Continued ~~on page 252~~)

Precious Metals, Properties of (File Fact) —May, p 133

Nonferrous Metals

Price-Volume Ratios for Plastics and Metals (File Fact)—June, p 137
Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103

Nonmetallic Materials and Plastics

Automatic Blow Molding, Thin Hollow Plastic Shapes Produced by—Feb., p 88
Carbon Graphite Materials and Parts (MATERIALS & METHODS Manual)—Apr., p 119
Casting Resin Used for Low Cost Forming Tools, New—May, p 105
Cellular Rubber Insulates, Seals and Cushions—Apr., p 91
Fluids for Hydraulic Systems—Jan., p 100
Fluorocarbon Plastics Bonded to Metals and Rubbers to Provide New Composite Materials—Mar., p 96
Intricate Forming of Glass Accomplished by New Photochemical Method—May, p 94
Lithium Ceramics, New—Jan, p 98
Mica Paper Developed for Electrical Insulation—June, p 174
Natural and Synthetic Rubber, Relative Properties of (File Fact)—Apr., p 137
Plastics as Alternate Materials (MATERIALS & METHODS Manual)—Feb., p 101
Potting Compound Has Controlled Shrinkage, New—June, p 117
Price-Volume Ratios for Plastics and Metals (File Fact)—June, p 137
Reinforced Plastics in Automotive Body—Apr., p 109
Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
Technical Ceramics for Wear Resistant and Dimensionally Stable Parts—Mar., p 88

Plastics (see Nonmetallic Materials)

Plastics as Alternate Materials (MATERIALS & METHODS Manual)—Feb., p 101
Porcelain and Ceramic Coatings, New Developments in—May, p 87
Potting Compound Has Controlled Shrinkage, New—June, p 117

Powder Metallurgy

Metal Powder Parts, The Plus and Minus of Making Your Own—Apr., p 101
Precious Metals, Properties of (File Fact)—May, p 133
Precipitation Hardening Stainless Steels Show Advantages Over Standard Grades—May, p 99
Pre-Plated Drawn Steel Wire Saves Scarce Metals—May, p 96
Price-Volume Ratios for Plastics and Metals (File Fact)—June, p 137
Protective Treatment for Aluminum Simplifies Processing at Reduced Costs, New—Feb., p 91
Reinforced Plastics in Automotive Body—Apr., p 109
Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
Rocket Parts Effectively Heat Treated in Mechanized Salt Bath Furnace—Jan., p 90
Salt Spray Tests, A Critical Look at—Feb., p 77
Salt Spray Tests, A Critical Look at (Discussion)—Mar., p 77
Silicon Coatings Protect Metals Against Severe Service Conditions—Jan., p 82
Soldering Aluminum, Materials and Procedures for—Apr., p 116
Spring Materials, How to Choose (Part I) —Jan., p 85
Spring Materials, How to Choose (Part II) —May, p 112
Stainless Steels, Relative Workability of—June, p 135
Steel Compositions to Conserve Critical Alloying Elements, New (File Fact)—Mar., p 121
Steel for Low Temperature Service, How to Select—Jan., p 75

Steels

Boron Steels, Hardenability as the Criterion for Selecting—Mar., p 84
Boron Steel, Tentative Hardenability Bands for New—Mar., p 123
Boron Treated Types of Alternate Steels (File Fact)—Feb., p 127
Chromium-Vanadium Steels (File Fact)—Apr., p 139
Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 and Type 316 Stainless Steel (File Fact)—Jan., p 115
Harden Small Steel Parts, How to—Apr., p 112
Inert-Gas-Shielded Metal Arc Process, Carbon Steel Successfully Welded by—Feb., p 86
Needle Tubing Extended to Mechanical Applications—June, p 106
Nitriding, How to Case Harden Steel by —May, p 90
Precipitation Hardening Stainless Steels Show Advantages Over Standard Grades —May, p 99
Pre-Plated Drawn Steel Wire Saves Scarce Metals—May, p 96
Price-Volume Ratios for Plastics and Metals (File Fact)—June, p 137
Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
Spring Materials, How to Choose (Part II)—May, p 112
Stainless Steels, Relative Workability of (File Fact)—June, p 135
Steel Compositions to Conserve Critical Alloying Elements, New (File Fact)—Mar., p 121
Steel for Low Temperature Service, How to Select—Jan., p 75
Technical Ceramics for Wear Resistant and Dimensionally Stable Parts—Mar., p 88

Testing and Inspection

European Research on the Behavior of Metals Yields Promising Results—June, p 93
Ultrasonic Inspection Checks Quality of Brazed Joints—June, p 102
Titanium and its Alloys (MATERIALS & METHODS Manual)—May, p 117

Titanium, Zirconium and Tantalum

Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 and Type 316 Stainless Steel (File Fact)—Jan., p 115
Electroplated Coatings on the Light Metals (MATERIALS & METHODS Manual)—June, p 119
Titanium and its Alloys (MATERIALS & METHODS Manual)—May, p 117
Trepanning Speeds Boring Holes in Heavy Metal Sections—May, p 174

Tubing

Needle Tubing Extended to Mechanical Applications—June, p 106
Ultrasonic Inspection Checks Quality of Brazed Joints—June, p 102

Welding and Joining

Brazing and Soldering Materials, How to Select (MATERIALS & METHODS Manual) —Mar., p 105
High Temperature Fastening Problem Solved with Special Self-Locking Nuts—June, p 109
Inert-Gas-Shielded Metal Arc Process, Carbon Steel Successfully Welded by—Feb., p 86
Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
Soldering Aluminum, Materials and Procedures for—Apr., p 116
Ultrasonic Inspection Checks Quality of Brazed Joints—June, p 102
Wet Blasting Performs Many Cleaning and Finishing Operations—Apr., p 98

Authors' Index

Arntzen, C. E., Silicone Coatings Protect Metals in Severe Service—Jan., p 82
Barry, Frederick M. (see Wolff, Edward L.)
Bedford, Gordon T., Precipitation Hardening Stainless Steels—May, p 99
Birdsall, G. W., Soldering Aluminum, Materials and Procedures for—Apr., p 116
Blackman, B., Gold Scrap Recovery Methods Applicable to Scarce Materials—Mar., p 102
Bleakley, W. Y., Interleaving Paper for Aluminum Inhibits Water Stain, New—Feb., p 176
Bonanno, Joseph L., Metal Powder Parts, The Plus and Minus of Making Your Own—Apr., p 101
Chase, Herbert, Heat Treating of Connecting Rods, Production—June, p 100
Clauser, H. R., Brazing and Soldering Materials, How to Select (MATERIALS & METHODS Manual)—Mar., p 105
Dilks, B. H. (see Stark, R. E.)
Dolan, Thomas J., European Research on the Behavior of Metals Yields Promising Results—June, p 93
Du Bois, J. H., Automatic Blow Molding, Thin Hollow Plastics Shapes Produced by—Feb., p 88
Du Mond, T. C.
  Aluminum Alloy Die Castings Used in Complex Automotive Parts—Jan., p 80
  Materials Engineering at Westinghouse Develops, Improves and Applies Materials—Apr., p 87
  Plastics as Alternate Materials (MATERIALS & METHODS Manual)—Feb., p 101
  Review of Materials Engineering Developments in 1951 (MATERIALS & METHODS Manual)—Jan., p 103
Everhart, John L.
  Copper-Clad Aluminum Can Conserve Copper in Many Uses—Feb., p 82
  Nitriding, How to Case Harden Steel by—May, p 90
  Steels for Low Temperature Service, How to Select—Jan., p 75
  Titanium and its Alloys (MATERIALS & METHODS Manual)—May, p 117
  Wet Blasting Performs Many Cleaning and Finishing Operations—Apr., p 98
Fangemann, M. Gerard
  Spring Materials, How to Choose (Part I) —Jan., p 85
  Spring Materials, How to Choose (Part II) —May, p 112
Faroni, Charles F., High Temperature Fastening Problems Solved with Special Self-Locking Nuts—June, p 109
Greenberg, H., Ultrasonic Inspection Checks Quality of Brazed Joints—June, p 102
Griffeth, R. L., Mica Paper Developed for Electrical Insulation—June, p 174
Heinzman, C (see Blackman, B.)
Herbst, H. T., Inert-Gas-Shielded Metal Arc Process, Carbon Steel Successfully Welded by—Feb., p 86
Kelley, Jr., S. G.
  Drawing Brass Cuts Finishing Costs, New —Mar., p 82
  Technical Ceramics for Wear Resistant and Dimensionally Stable Parts—Mar., p 88
Kenmore, Herbert, Pre-Plated Drawn Steel Wire Saves Scarce Metals—May, p 96
Kincaid, Homer, Induction Descaling Proves a Fast, Economical Method for Cleaning Steel —Jan., p 97
Knowlton, H. G., Boron Steels, Hardenability as the Criterion for Selecting—Mar., p 84
LaQue, F. L., Salt Spray Tests, A Critical Look at—Feb., p 77
Lacey, C. C. (see Bleakley, W. Y.)
Loria, Edward A., Machinability of Thin Gray Iron Castings, How Structure Influences Machining—Feb., p 99
Lucht, Fred W., Trepanning Speeds Boring of Heavy Metal Sections—May, p 174
McElrath, Jr., T. (see Herbst, H. T.)
Mitchell, A. J., Black Oxide Finish Produced on Steel by Chemical Dip Method, Low Cost —Mar., p 92
O'Keefe, Philip
  Carbon and Graphite Materials and Parts (MATERIALS & METHODS Manual)—Apr., p 119
  Cellular Rubber Insulates, Seals and Cushions—Apr., p 91
  Electroplated Coatings on the Light Metals (MATERIALS & METHODS Manual)—June, p 119
  Porcelain and Ceramic Coatings, New Developments in—May, p 87
Richards, John T., Beryllium Copper Useful for Large Machine Parts—June, p 97
Rose, Kenneth
  Fluids for Hydraulic Systems—Jan., p 100
  Harden Small Steel Parts, How to—Apr., p 112
  Intricate Forming of Glass by New Photochemical Method—May, p 94
  Rocket Parts Effectively Heat Treated in Mechanized Salt Bath Furnace—Jan., p 90
Rowley, R. D. (see Arntzen, C. E.)
Stark, R. E., Lithium Ceramics, New—Jan., p 98
Starr, John, Casting Resin Used for Low Cost Forming Tools, New—May, p 105
Stricklen, R., Protective Treatment for Aluminum Simplifies Processing at Reduced Costs, New—Feb., p 91
Wainer, Eugene, Aluminum Photographic Process Has Industrial Applications—Apr., p 176
Wolff, Edward L., Continuous Casting, Better Brass Mill Products Produced by—Apr., p 94
Younglove, E. R. (see Griffeth, R. L.)

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M58

Feature Articles

How to Select Steels for Low Temperature Service . . . . . *John L. Everhart* **75**
Toughness properties and design details critically influence performance at sub-zero temperatures

Aluminum Alloy Die Castings Used in Complex Automotive Parts . . . *T. C. Du Mond* **80**
Why Ford engineers chose this materials-form combination for their automatic transmission

Silicone Coatings Protect Metals in Severe Service . . . . . *C. E. Arntzen & R. D. Rowley* **82**
Properties of the various types, results of service tests, and typical applications

How to Choose Spring Materials . . . . *M. Gerard Fangemann* **85**
This first of a two-part article describes available spring types and basic design factors

Rocket Parts Effectively Heat Treated in Mechanized Salt Bath Furnace . . . *Kenneth Rose* **90**
Details of high production hardening procedure that provides accurate hardness control and minimizes distortion and scaling

Materials at Work **92**
Nickel alloys in gas turbine, aluminum bulb bases, ceramic thread guides, phenolic circuit breaker

Induction Descaling Proves a Fast, Economical Method for Cleaning Steel . . *Homer Kincaid* **97**
New process that "pops" scale from hot-worked steel prior to machining pays off in longer tool life

New Lithium Ceramics . . . . *R. E. Stark and B. H. Dilks, Jr.* **98**
New series features high thermal shock resistance and controlled thermal expansion

Fluids for Hydraulic Systems—The Basic Types and Where to Use Them . . *Kenneth Rose* **100**
Exacting service requirements narrows choice to a relatively small group of materials

Materials & Methods Manual No. 78

Review of materials engineering developments in 1951 . . . . . *T. C. Du Mond* **103**

Engineering File Facts

No. 221—Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 and Type 316 Stainless Steel **115**

Departments

The Materials Outlook 3
Materials Control Orders . . . 6
News Digest 9
New Materials & Equipment . . 119
Meetings and Expositions . . 190
Book Reviews 192
Manufacturers' Literature . . . 211
Advertisers and Their Agencies . 226
The Editor's Page 228

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To Management:

We suggest you bring this page to
the attention of your Purchasing,
Production and Maintenance Depts.
One or more of its paragraphs may
lead to the solution of critical
procurement problems in your plant.

Stymied by Steel Shortages?

These 6 Suggestions May Help!

① **Handicapped by restrictions on nickel-bearing 18-8 stainless?** If you are, straight chrome stainless may enable you to continue your stainless production. For instance, type 430—the most widely used straight chrome steel—can often be substituted for type 302 in applications subject to mild corrosion. Ryerson offers you the largest and most diversified stocks of straight chrome stainless including types 405 and 430 sheets, type 430 plates and type 416 bars.

② **Manufacturers plagued by seamless tubing scarcities** will find that bright-finish, hot rolled welded tubes in 11 gauge and 3/16″ walls can often be used as an alternate for seamless tubes in the same sizes. These welded tubes are in good supply at Ryerson in a wide range of round and square sizes.

③ **If you are having trouble adopting interim and lean alloys** because of the unfamiliar analyses of these new steels, let Ryerson metallurgists work with you. We test all alloys and can assure the hardenability desired. Heat treatment guide with every shipment.

④ **Faced with the problem of finding workable substitutes for special plate shapes?** You may find the right answer in forgings. You can get complete information on forgings from our sales representative.

⑤ **In addition to these alternate steels** we recommend a superior babbitt—Glyco Babbitt Metal—instead of more expensive and restricted high tin babbitt. Product of an exclusive Ryerson formula, Glyco is a lead base alloy with physicals equal to tin base types.

⑥ **And, remember**—please give us full information when ordering. For instance, when we know the exact size or length multiple—the cut size or length you will actually use—we may be able to fill your order from smaller pieces or "shorts." Knowledge of acceptable alternates also helps. But, no matter what your requirements, we urge you to check with us. We will always work closely with you—help you get what you need.

RYERSON STEEL

JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CINCINNATI • CLEVELAND
DETROIT • PITTSBURGH • BUFFALO • CHICAGO • MILWAUKEE • ST. LOUIS • LOS ANGELES • SAN FRANCISCO

The Materials Outlook

A lot of bubbles seem ready to pop. The Commerce Department says U. S. output has been leveling off. Alex Lewyt denies that consumer appliance shortages are ahead. The NPA eased metal restrictions on small users. Among the producers, steel, tin and even copper people are screaming that both the long- and short-term shortages are being magnified by government scare talk and buying restrictions. It is certain that most plastics are in plentiful supply right now. This may add up to easier supplies — soon. Remember that the boom-or-bust nature of government price and supply controls makes an overnight transition from shortage to oversupply inescapable. Everyone is fighting for more than they need, and as soon as they get it, oversupply sets in.

The NPA is frowning on design changes in both civilian goods and weapons. If consumer resistance holds up, this could touch off a rush to alternate materials by way of product development. Plastics would probably get the big play.

An analysis of the metals industry is being offered in booklet form by Merrill, Lynch, Pierce, Fenner & Beane, New York underwriting and financial house. Written for investors interested in steel and nonferrous stock, the book gives facts, tables and charts on the production and applications of each metal. Each company's place in the industry is summarized. The analysis looks beyond military demand and covers the prospects in each industry for the future.

The use of palladium as a substitute for platinum in jewelry has increased considerably. The price fluxuations of platinum and government restrictions on its use are the reasons for the change. The metals are similar in appearance but palladium costs one-fourth as much. The light weight of palladium is another advantage.

A process developed by Republic Steel and Ferro Corp. gives a single coat of titania-opacified enamel directly on iron and non-premium steel. Cost savings are the big claim. The thin coat also resists impact and heat better. It can be bent, drilled, sheared and sawed with clean edges. This, and low-temperature firing developments, portend expansion of the porcelain enamel industry.

For mobile transformers, where a good appearing, gray, durable matte finish is desired, stainless steel paint is proving to be just the right answer, and is now standard with Westinghouse. It seems to withstand alkali

(Continued on page 4)

The Materials Outlook *(continued)*

atmospheres which penetrate aluminum paint. It does not chalk like other outdoor gray paints either.

The most conspicuous trend in light sources is the rapid growth of mercury-vapor lamps. Last year all illuminants — incandescent, fluorescent and vapor — grew by 15%; at the same time mercury more than doubled, according to Westinghouse. The efficiency of mercury is attractive. With the introduction of fluorescent-mercury lamps, the obstacle of the blue-green color of previous mercury lamps was removed.

An alkaline electrolytic derusting process for steel, cast iron and malleable iron is now on the market. No acid is used, and the supplier claims there is no attack on the metal. The solution operates at room temperature and does not attack surrounding equipment. High carbon steels, sometimes discolored by even inhibited acids, can be safely derusted without tarnishing. The process also saves time over acid pickling.

A new technique for drilling, grinding, turning, milling, threading and tapping tungsten metal with ordinary metal-working machines has been developed by Philips Laboratories. Tolerances are comparable to those achieved with steel or brass. Tungsten tubing has been made with an OD of 0.066 in. ± 0.0005 in., and an ID of 0.060 in. ± 0.001 in. An 0-80 tungsten screw 11/16 in. long was made with a 0.025-in. hole drilled through its entire length.

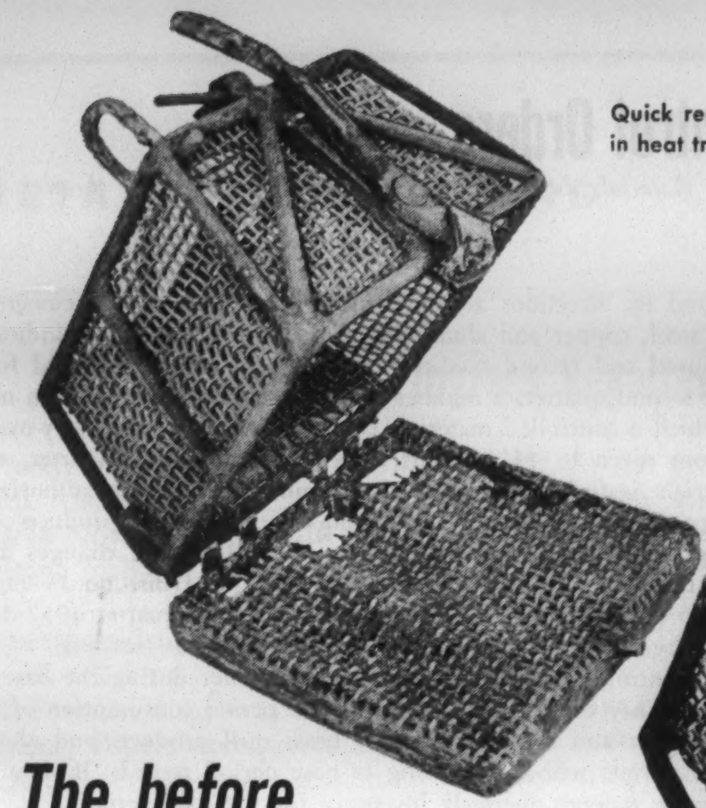
A new method of joining silicone rubber to steel in a permanent bond "stronger than the rubber itself" is a recently reported development by G-E. A thin glue-like primer forms the bond. It withstands temperatures from -85 to 500 F. Engine shock mounts are a suggested application.

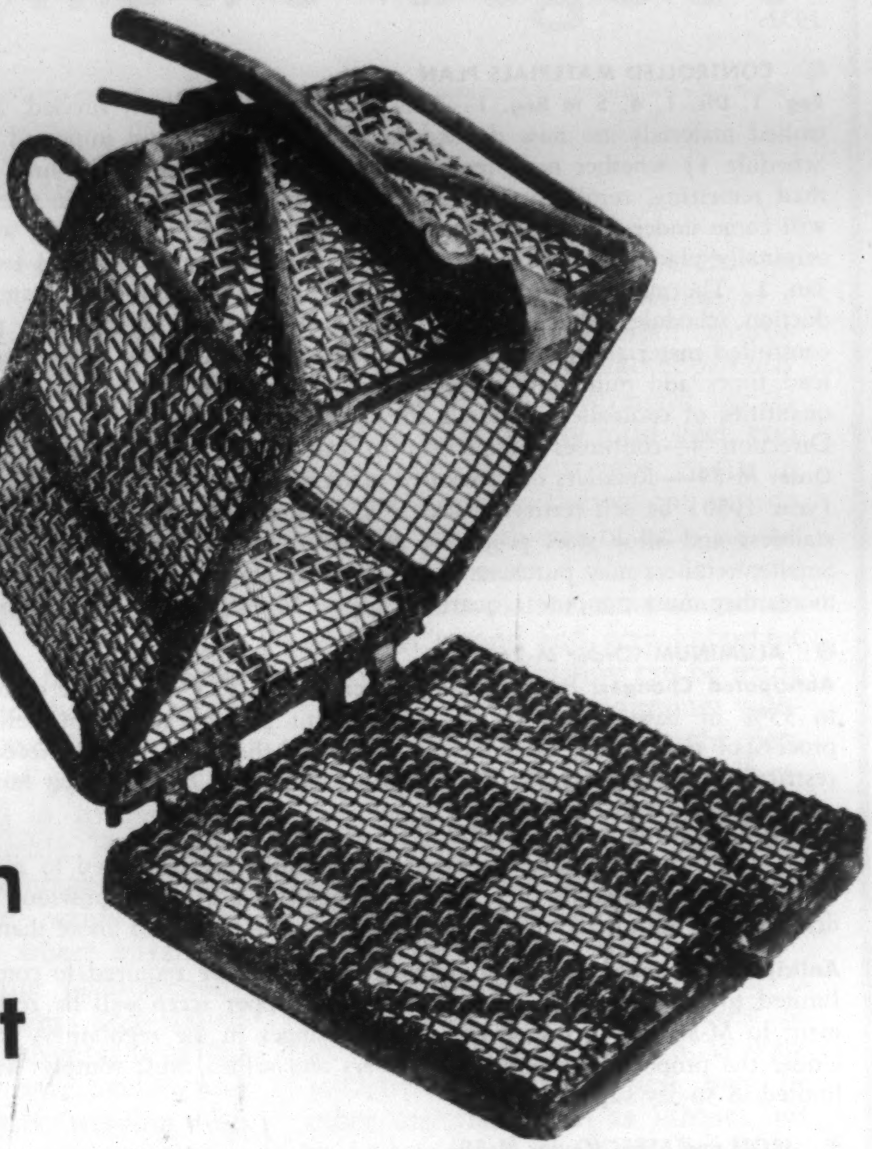
A new one-operation chemical process colors and protects aluminum. Yellow, green, blue, gold, brass and other colors are possible. The coatings are relatively non-conductive and have a thickness of about 0.0001 in. In most cases, a clear lacquer is used over it. Aluminum hardware, jewelry, slide fasteners, buttons, nameplates, automobile trim, bead chain, electrical fittings and pencil parts have been treated successfully.

Liquid carbon dioxide is being used as a metal-cutting coolant. Work is experimental, but drilling, turning and broaching with the very cold liquid applied to cutting points look promising. Tool life is extended and service between grinds is extended. Titanium and high-hardness materials are being explored for the process.

Supplies of marine paints for civilian and commercial use in 1952 will fall below the 1951 level as a result of mounting military demands and a continued short supply of essential raw materials like copper, vinyls and rubber. Shortage of steel containers is another hold-up, and paper and glass packaging may be used for paints.

See page 6 for "Materials Control Order"





Quick repairs give extra long life to this Inconel basket used in heat treating small steel parts in a 1600° F. molten salt bath.

The before and after story of an Inconel basket in 1600° F. molten salt

Salt bath dump bottom baskets for case hardening parts have to stand extra tough service.

Take this Inconel basket for example...

Time after time—loaded with 80 to 100 pounds of small steel parts—it has taken half-hour 1600° F. baths in molten salts.

For 26 months the basket took such abuse. Then it was returned to Rolock, Inc. to be repaired. Then it went back to work again and gave 13 months more service.

Now it has been repaired again and is back on the job for the *third* time.

Just take a look at the photo on the left. That's how it looked when sent back for repairs the second time. Now take a look at the one on the right. Yes, it's the same basket after being repaired. Now it's back in service adding more time to an already outstanding service life of 39 months!

The fabricator, Rolock, Inc. of Fairfield, Conn. chose Inconel for the basket because of its strength and workability and because of its good resistance to high temperature oxidation and corrosion.

Right now, of course, Inconel is on extended delivery because so much is needed for defense. Therefore, it will pay you to place your orders for it well in advance of the time you expect to use it. Consult your supplier about availabilities. And remember, Inco's Technical Service Section is always ready to assist you with your heat treating problems. Write them today.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

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INCONEL®... for long life at high temperatures

Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Nov. 11, 1951 through Dec. 10, 1951.

● CONTROLLED MATERIALS PLAN

Reg. 1, Dir. 1, 4, 5 to Reg. 1—This regulation, extensively revised, and its directions are now incorporated into one document. Controlled materials are now defined to mean "domestic and imported steel, copper and aluminum in the forms and shapes indicated (in Schedule 1) whether new, remelted, rerolled or redrawn, including used and second quality materials . . . which are sold for other than remelting, rerolling or redrawing purposes." Beginning in the second quarter, a number of steel, copper and aluminum materials will come under the regulations of Schedule 1. The period during which a controlled materials consumer may accept a carry-over order originally placed for delivery in the previous quarter is extended from seven to 15 days after the expiration of a quarter, effective Jan. 1. The manufacture of any product containing controlled materials is forbidden unless the manufacturer has an authorized production schedule. Official interpretations are included which have permitted the use of DO ratings on orders for products or non-controlled materials for delivery after the expiration of the quarter for which the related allotment is valid. Other changes affecting lead times and minimum mill quantities were included as well as revisions of three directions as follows: Direction 1—raises the quantities of controlled materials for which manufacturers of Class B products may self-certify orders for second quarter 1952 delivery; Direction 4—continues permission to use foreign steel without charging it to allotments; and Direction 5—revoked.

Order M-89— Retailers of controlled materials may obtain the class of controlled materials sold over-the-counter during the base period (year 1950) by self-certifying orders and using allotment symbol W-5. They can obtain: 100% of base period consumption of carbon, stainless and alloy steel products; and 60% of base period use of copper and copper-base alloy brass mill products and aluminum. Smaller retailers may purchase specified dollar amounts of controlled materials without referring to base period records. If they require more, they must compute a quarterly quota. Inventories are limited to the average quarterly inventory for the base period.

● ALUMINUM (Order M-26)

Anticipated Changes: Proposed amendments will: (1) reduce use of aluminum in packaging such products as beverages and cosmetics to 35% of base period quota; (2) Permit packers to accept delivery of aluminum closures on order with manufacturers, or in process of production, even though receipt of the order would exceed a 75-day supply; and (3) permit packers to use, regardless of restrictions, any closures in inventory in excess of a 75-day supply but not usable beyond permitted quotas.

● COPPER (Orders M-16, M-82)

Brass and bronze foundries, wire and brass mills are permitted to place orders for, and accept delivery of up to 50% of the quantity of copper raw materials they were authorized to use in the previous month. This does not apply to the small brass and bronze foundries whose authorization to purchase covers a period of more than one month.

Anticipated Changes: Sellers and buyers both will be required to comply with regulations of M-16. Dealers' scrap inventories will be limited to a 30-day supply and the sale of copper scrap will be restricted to those holding allocation certificates. Proposed amendment to M-82 may bring several minor changes in the regulations governing the distribution of brass mill products to distributors. Under the proposed revisions both buyers and sellers must comply with the order and dealers' inventories of copper scrap will be limited to 30-day supplies.

● IRON and STEEL (Order M-80)

Anticipated Changes: The present tight situation in nickel-bearing stainless steels may lead to an amendment expanding the list of prohibited uses and, perhaps, a re-examination of the entire picture of nickel allocations. The relatively greater supply of chromium steel may permit the separation of chromium products from nickel-bearing stainless steels.

● RUBBER (Order M-2)

Many restrictions on the total consumption of new rubber are eliminated under amendment effective Jan. 1. Provisions include: (1) permission for private contracting for latex importation if Government-held stocks are liquidated; (2) elimination of allocation of GR-S synthetic rubber but maintenance of inventory limitations; (3) the continued allocation of butyl and the limitation of inventories in the hands of consumers to 30-day supplies; and (4) restrictions on purchasers of GR-S to limit their purchases of the cold rubber form to 46% of the total GR-S obtained in one order.

● TIN (Order M-67)

Foil allotment for products in Groups 1 to 4 in the first quarter is 74% of permitted use. Producers of products in Group 5 will receive 55½% of permitted use and others 47%. Military needs are allotted 3,600,000 lb, and more may be allotted if additional military orders are received.

Anticipated Changes: Extension of inventory limitations on tinplate will permit a minimum working inventory adequate for 60 days. Attempts are being made to extend the deadline from seven to 15 days beyond which controlled materials cannot be delivered in the quarter following that in which they were ordered.

● ZINC (Order M-9)

The quantity of slab zinc that may be purchased in any month without allocation certificates is reduced from 20 to 10 tons. Applications for allocations must be filed no later than the 15th of any month for delivery the succeeding month. Producers not receiving orders for all their available slab zinc must report to the NPA whatever excess metal they have in any one month.

● MRO (Order M-79)

Sets up procedure to meet essential foreign requirements for maintenance, repair and operating supplies. Replacement parts for machine tools, parts and accessories for motor vehicles, specialized industrial gloves, leather belting and abrasives are eliminated from coverage by the order. Coverage is also limited to a unit value of not more than $750 on such items as laboratory supplies, instruments and equipment.

● NPA Regulations

Dir. 3 to Reg. 2—Simplifies Direction 3 to permit the assignment of new ratings to either the Defense Dept. or the AEC without amending this direction. Chemicals for defense purposes ordered by U.S. manufacturers from Canada are identified under the new symbol C-5.

MATERIALS ENGINEERING News Digest

Magnesium Progress Reported at Association Meeting

The seventh annual meeting of the Magnesium Association was held in New York in November. A. C. Winston, assistant manager of the Magnesium Div. of Dow Chemical Co., was reelected president of the association. E. H. Perkins, president of Brooks & Perkins, Inc., was named vice president. Papers were presented at two technical sessions and a session devoted to magnesium casting. At a general meeting, P. D. Helser, Chief of the Magnesium and Titanium Branch of NPA, told members that the government's magnesium program for 1952 will provide for sufficient metal for all military and stockpiling needs, but not for all civilian requirements.

Magnesium casting alloys containing rare earth metals were reviewed by T. C. McDonald of the Dow Chemical Co. It was noted that zirconium is used as a secondary alloying element in these alloys to refine the grain and improve properties. These rare earth alloys are somewhat more expensive than those using aluminum or zinc, but show much higher creep strengths at high temperatures. Creep strengths of 8000 psi at 400 F are available in rare earth metal alloys, for example. In the line of future developments, Mr. McDonald expressed the opinion that research and development should be concerned with bringing thorium-containing alloys into production. These alloys promise improvements in creep strengths above 400 F.

D. A. Tooley of Consolidated Vultee Aircraft presented a paper on B-36 experience with magnesium. The superiority of magnesium over aluminum in fatigue resistance at low stress levels was noted. The corrosion of magnesium in the B-36 has not been a problem, according to Mr. Tooley, probably because of the care taken in selecting magnesium finishes. The desirability of developing new magnesium alloys with greater strength and high temperature resistance was stressed.

Welding magnesium by the Aircomatic process was surveyed by Harold Robinson of Air Reduction Co., Inc. At the present stage of development, the Aircomatic process lacks the overall usefulness and flexibility of the tungsten-arc process for welding magnesium. The disadvantages are low penetration and excessive spatter in the low current density range, and in some cases, excessive deposition rates in the high current density range. The process is limited to flat, horizontal and vertical-down deposits.

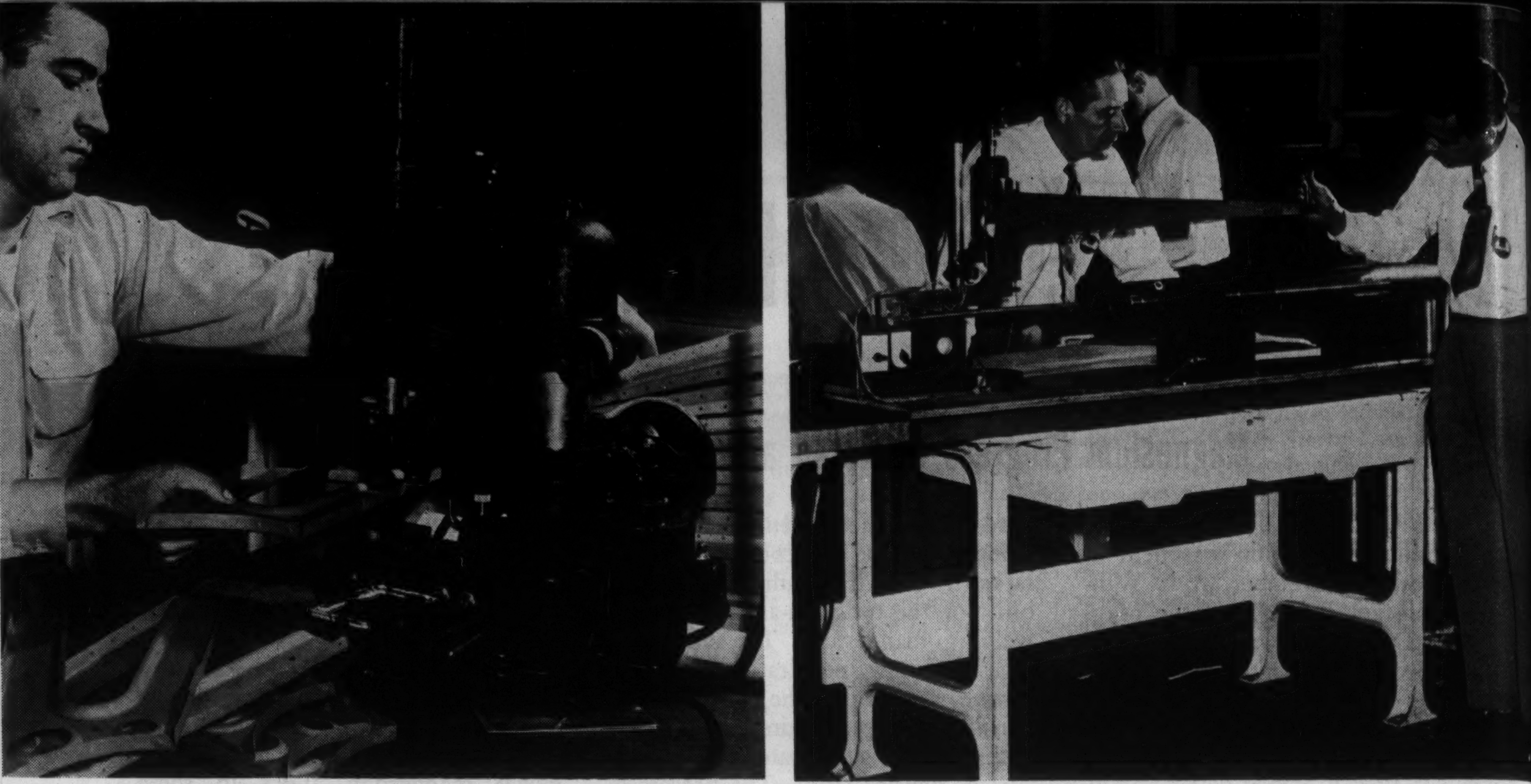
The advantages of the Aircomatic process as applied to the welding of magnesium are excellent quality welds in all types of joints in plate thicknesses from 1/8 in. to the maximum thickness available. The process has particular advantage for fillet welds and groove welds in the heavier thicknesses where advantage can be taken of the phenomenally high deposition rates and travel speeds. Lastly, the advantages of the process, continuous wire feeding and fluxless semi-automatic welding with the flexibility of manual manipulation, can be applied successfully to the welding of magnesium.

R. Smallman-Tew of A. V. Roe Canada, Ltd., presented a paper on the use of magnesium in aircraft construction. He stated that the revival of interest in magnesium as a structural aircraft material, shortly after aluminum alloys had apparently swept the field with strength figures equal to good quality mild steel, and with one-third the weight, is due to the realization by the weight experts that the strength-weight ratio of the newer magnesium alloys in some cases exceeds that of some aluminum alloys. A second and very important factor is that a structure can be made very much stiffer in magnesium without suffering a serious weight penalty, and stiffness is a principal requirement of modern high-speed aircraft. New and stronger aluminum alloys are being developed, it was conceded. Steel castings have become a must for certain components.

The introduction of titanium is creating very considerable interest, as its strength-to-weight ratio is very attractive, and there well may be other materials, such as lithium, yet to be produced commercially, which will rival magnesium's claim to have the highest strength for the lowest weight. By and large, however, magnesium will remain with us, as a useful alloy, for many decades to come.

Kure Beach Project Expanded

Further facilities for the study of sea water corrosion are being added to the Kure Beach project. A salt water evaporator and distillation unit are among the new units.



The Fairchild Aircraft Div. of the Fairchild Engine and Airplane Corp. uses some interesting testing machines in the production of C-119 Flying Boxcars. The machine at the left tests the hardness of sheet metal parts, automatically stamping acceptable parts. The precision electric gage at the right determines the exact wall thickness and concentricity of tubing.

Glenn L. Martin Pushes Titanium Research

The Glenn L. Martin Co. of Baltimore has for the last few years been carrying on a research program on the adaptability of titanium in airframe applications. The investigations were from two points of view, comparative cost and the special fabrication problems involved.

The work is entirely on an experimental basis, and the results have been accumulated as design data. The research has been confined largely to the bar and sheet forms of the pure metal. Titanium alloys are still being developed in such great variety that the Martin engineers have postponed tests on any of them. The alloys will be investigated more thoroughly when the titanium suppliers have standardized on a relatively few basic alloy formulas.

Specifically, the Martin Metallurgical Laboratory has been conducting tests on such items as titanium bolts and on firewalls for piston engines—both with weight-savings in mind. In addition, as part of a recent project for the design of a suitable shroud to protect wing surfaces from jet engine exhaust, flame impingement tests were applied to titanium sheet. Spot-welding of sheet has been performed in a number of tests, and bar titanium has been checked for tension, compression and shear values, as well as for the determination of notch-fatigue strength. Flash welding has likewise been done. No matching of titanium extrusions or forgings has yet been attempted.

The Martin Laboratory, of course, is cooperating with other airframe manufacturers and the Armed Forces in the work of the AIA's Aircraft Research Testing Committee, which is directed in part to the establishment of common denominators for the testing and processing of titanium and its alloys.

Need for Better Use of Scarce Jet Materials

Considerable savings of scarce metals appear possible in American production of jet engines, according to eight British specialists who visited the United States in July and August. The study, sponsored by ECA, was requested by the Anglo-American Council on Productivity to compare conservation of scarce materials.

American jet engines (other than those made under licenses granted from the U. K.) consume much larger quantities of cobalt, nickel and columbium than do comparable British ones, they reported. U. K. manufacturers, it is pointed out, are building jet engines with a shorter life span than the U. S. is. The British operate on the theory that engines built for war purposes will not last as long as the same engines in peace time.

The Britons were impressed by the vigorous short-term conservation measures being undertaken in the U. S. with lead, nickel and tin. They also noted that American processing made it possible to produce low alloy-content steel here. They recommended that British industries learn and use these methods.

Team members were impressed by the increase of the use of plastics in U. S. industry as substitutes for scarce materials. They felt that British industry would do well to examine the possibility of doing the same.

Briefs

- ● The Bettinger Corp. of Waltham, Mass., has opened the first plant in this country devoted entirely to high temperature ceramic coatings.

- ● A report presenting the findings of a survey conducted by Stanford Research Institute on the industrial uses of radioactive fission products is available from the Institute.

- ● Navy Bureau of Ordnance has announced a new spray-forming technique for fabricating large complex parts of high melting point metals.

Ontario Research Foundation Announces Controlled Density Steel

The Ontario Research Foundation has developed a process for producing finished and semi-finished articles of steel having any desired density and analysis within a very wide range. The object of the Foundation is to develop the process on a sound basis and to get it into use as soon as possible in industry. Discussions with companies interested in obtaining licenses to operate the process are under way at the present.

The process itself is extremely simple. Fine iron ore is made directly into the desired steel shape without melting or any other intermediate step. The dry, fine, prepared ore, generally finer than 60 mesh, is poured directly into suitable molds, then reduced at a temperature of about 2000 F and finally held for a longer treatment time of several hours at this same temperature. The resulting article has the composition and structure of normal steel, except that it contains a pre-determined amount of spherical voids which are not interconnected. This point is important, since the cellular structure of the steel allows it to be heated and hot worked without any great precautions to prevent excessive oxidation and scaling.

The future applications of this new engineering material have been divided into three classes, according to density. The density of steel is about 7.8 g per cu cm. Controlled density steel can be produced with any desired density from about 1.0 to 7.2.

Hot Worked Material

Controlled density steel may be produced with carbon contents ranging from less than 0.01% up to 1.5%. Alloying additions can also be made to the ore, and a wide variety of alloys have already been produced by this method. If the final form is to be rods, bars or wire, the iron ore is poured into a paper tube or some type of porous mold such as a Croning sand mold or porous graphite mold. The tubes full of ore are placed in a metal or ceramic sagger which is then filled with a mixture of coke breeze and limestone, and sealed. The loaded container is heated to 2000 F and held for sufficient time to produce the desired carbon content and density. The density of the finished article will depend upon the swelling or shrinking characteristics of the iron ore employed, on the maximum particle size, and on the particle size distribution. For hot working, the density of the steel coming from the furnace must be more than 3.0 and preferably over 4.0.

The resulting bars are removed from the saggers after they have cooled to about 100 F. The bars can then be re-heated and hot-worked by swaging. When the bars are reduced in cross sectional area by more than 80% in the hot swaging operation, the tensile properties, elongation, reduction of area and hardness correspond closely to the mechanical properties of ordinary steel of the same composition in the same stage of processing. The bars or rods can then be further cold worked and will attain the normal mechanical properties for cold drawn steel bars of the same analysis. Hot working can also be carried on quite easily as long as the shape is totally enclosed on at least four sides during working. The first working must be very gentle, but once a density of 7.5 or more has been obtained, hot working can proceed in the same way as with ordinary steel. The methods of annealing and hardening are the same as with ordinary steel.

It is believed that the cost of producing such material from controlled density steel will be higher than that of producing ordinary steel bars when the material is produced at the rate of about 20 tons per day from a continuous type of operation. There is no possibility that this process will compete with standard methods of producing steel on a large tonnage basis; however, it has interesting possibilities in locations remote from present steel plants, but close to suitable ore. It is also of interest in plants using 10 to 20 tons per day of steel who may find it advantageous to have their own closely controlled source of raw material, such as bar stock, tubing or sheet.

Substitute for Iron Powder

Controlled density steel in the range from 4.0 to 6.5 can be produced with about the same mechani-

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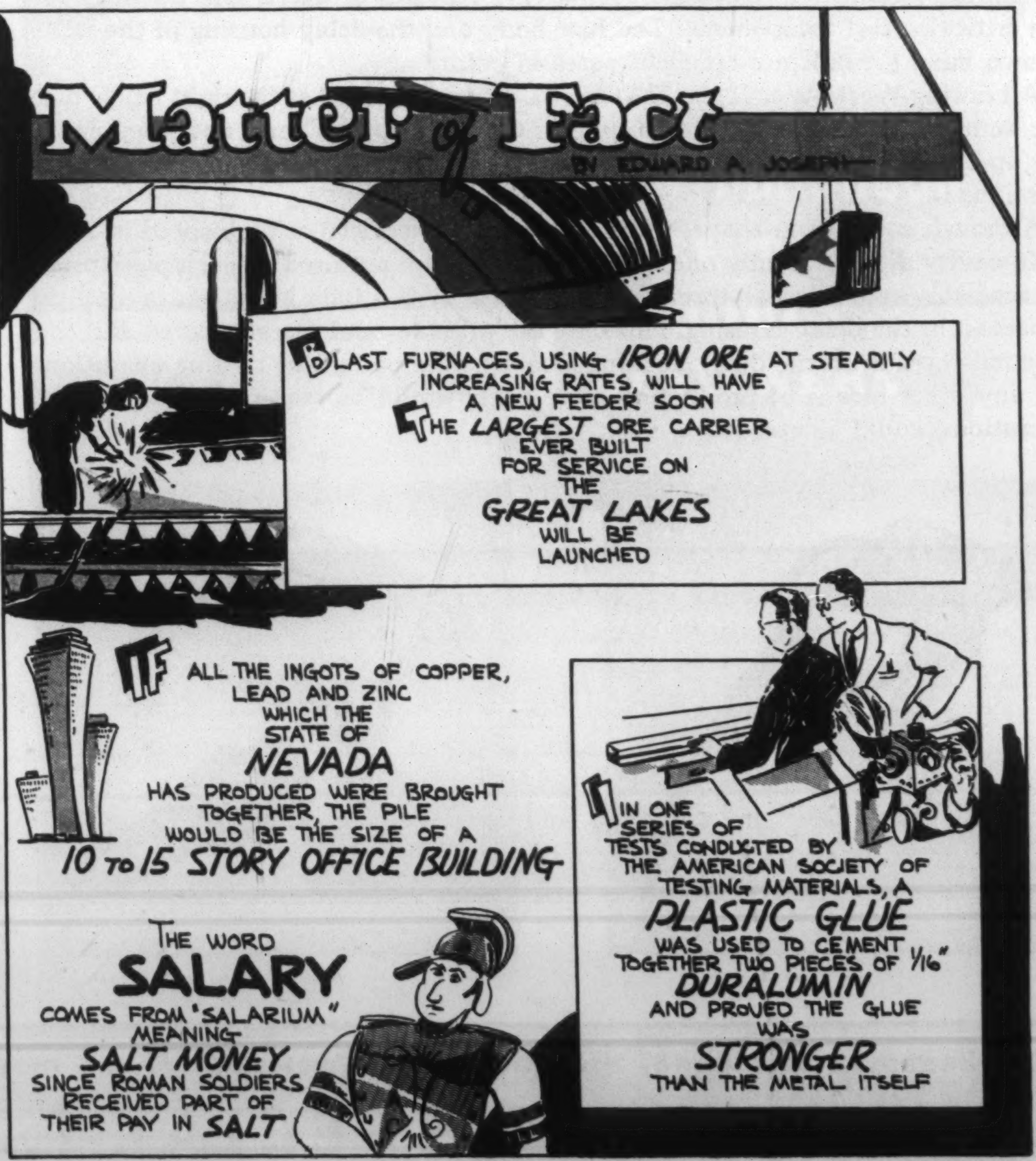
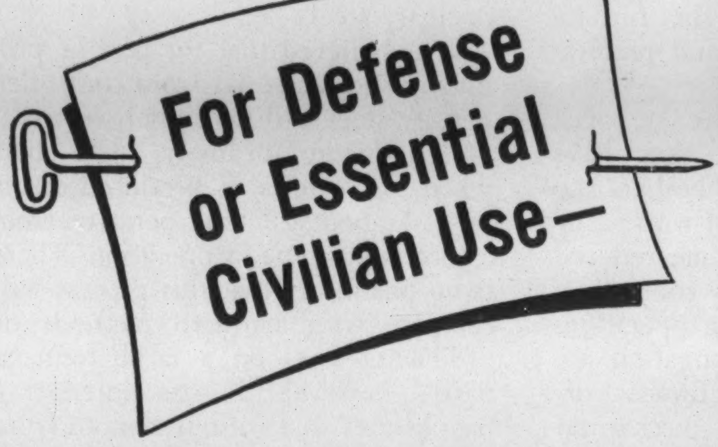

Matter of Fact
BY EDWARD A. JOSEPH
BLAST FURNACES, USING IRON ORE AT STEADILY INCREASING RATES, WILL HAVE A NEW FEEDER SOON
THE LARGEST ORE CARRIER EVER BUILT FOR SERVICE ON THE GREAT LAKES WILL BE LAUNCHED
IF ALL THE INGOTS OF COPPER, LEAD AND ZINC WHICH THE STATE OF NEVADA HAS PRODUCED WERE BROUGHT TOGETHER, THE PILE WOULD BE THE SIZE OF A 10 TO 15 STORY OFFICE BUILDING
IN ONE SERIES OF TESTS CONDUCTED BY THE AMERICAN SOCIETY OF TESTING MATERIALS, A PLASTIC GLUE WAS USED TO CEMENT TOGETHER TWO PIECES OF 1/16" DURALUMIN AND PROVED THE GLUE WAS STRONGER THAN THE METAL ITSELF
THE WORD SALARY COMES FROM "SALARIUM" MEANING SALT MONEY SINCE ROMAN SOLDIERS RECEIVED PART OF THEIR PAY IN SALT



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OBTAIN COMPLEXITY OF SHAPE AT LOW COST

Whether that new product is destined for essential home front consumption or for military use, investigate the cost-saving features of ZINC Die Castings for the critical metal components. The fuze body and the delay housing of the well-known hand grenade are excellent cases in point.

All during World War II the ZINC Die Castings pictured at the right below met the demands of unfailing performance in the "pineapples," and now they again are specified for the same critical components of the grenades in current production.

Although complex in shape, these castings are produced at high speed in multiple-cavity dies, with only one machining operation required on each piece prior to assembly—an internal thread is machined in the fuze body and a hole is broached in the delay housing. Not only are all holes and recesses cored, but the external threads on the delay housing also are obtained in the casting operation. By any other means of production more parts would be required, or secondary operations would be excessive.

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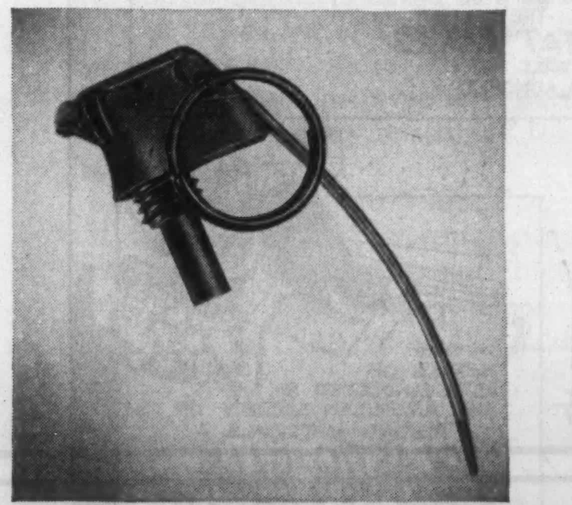

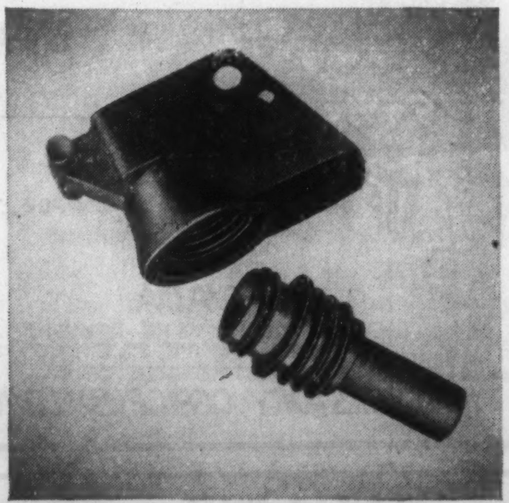

The Research was done, the Alloys were developed, and most Die Castings are based on

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News Digest

continued from page 11

cal properties and composition as pressed iron powder products. In this field, the process is in direct competition with powder metallurgy. Its use is attractive where the parts do not require much machining after coming from the furnace. Intricate parts like gears could not be made at a competitive price by this process. The tolerances are not of the order of pressed powder tolerances, but rather in the range of casting tolerances. The process should be regarded as a casting method, since many parts can be produced from molds which could not be pressed from powder. Where molds can be designed to be filled with dry ore powder, steel parts can be produced which require about the same amount of finishing as a cast iron or cast steel part.

In production of such simple shapes as bands, rings and bars, the controlled density steel process gives lower costs than powder metallurgy methods where the amount of finish machining to be done is low, and especially where required dimensional tolerances are not extremely rigid.

Light Steel

In the range of densities between 4.0 and 1.0 the main advantages of the material are its very low cost compared to other light weight metals and the fact that it can be produced directly from the furnace to reasonably close tolerances. In all cases the tensile strength of the material decreases with decreasing density. At a density of about 1.3 the mechanical properties compare with those of wood. At densities of 2.5 to 4.0 the tensile strength is increased to 15,000 or 20,000 psi. The ductility and impact strength are low. By proper preparation of the ore, shrinkage can be controlled to less than 1%. Particularly in cases where low cost and light weight are the main considerations, light steel can replace plastics, wood and, in some cases, magnesium and aluminum. Re-design of some parts is worthwhile to provide more material to withstand the required loading, since the cost of the resulting part may be far below the cost of a corresponding magnesium or aluminum part.

Light steel is fireproof, does not warp or split, and can be soldered, welded, painted and plated. The ma-

(Continued on page 152)

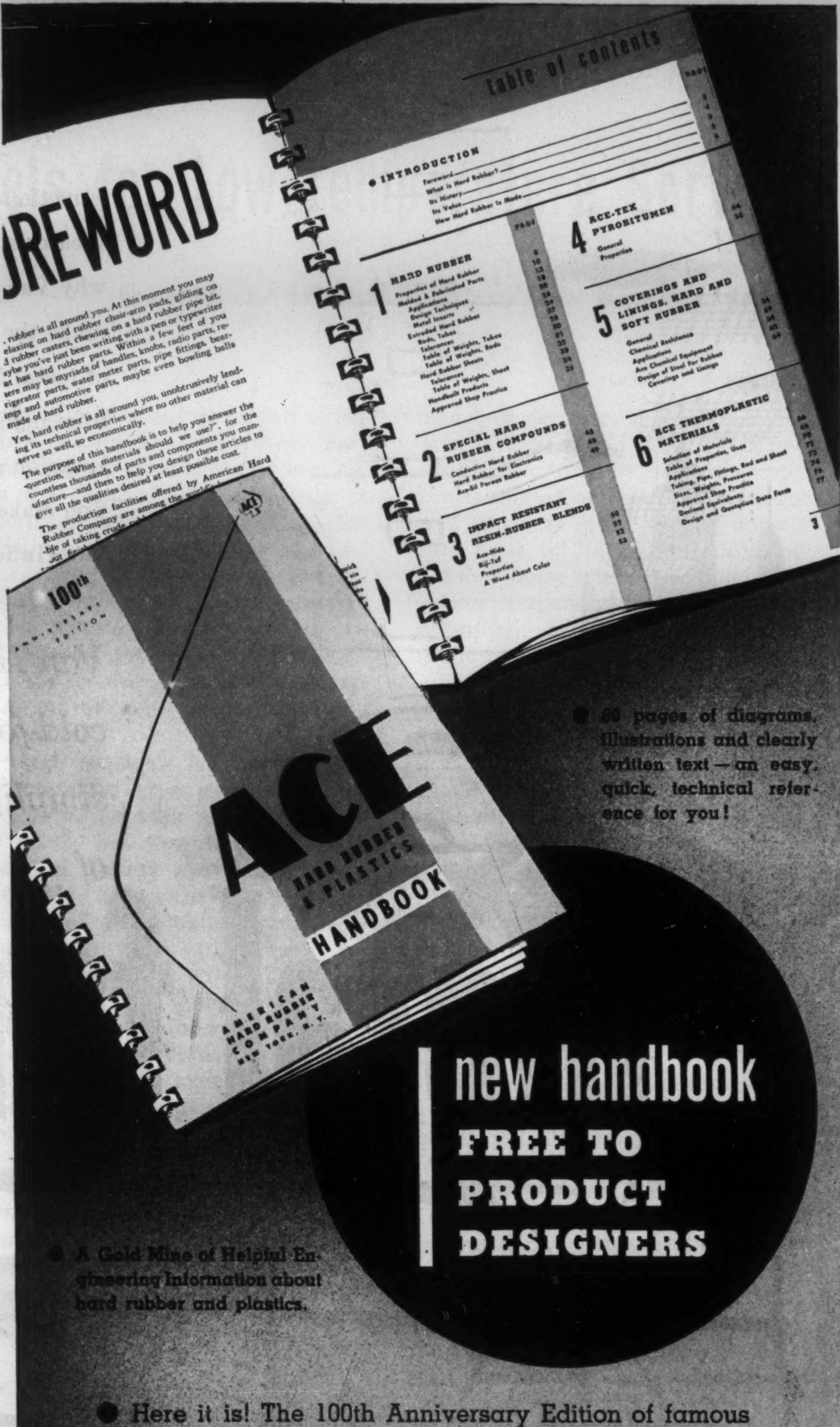
table of contents
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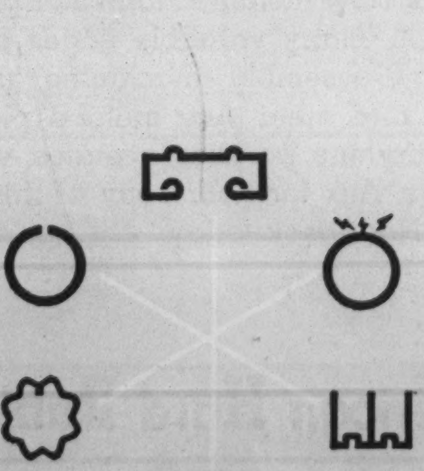

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Materials & Methods
JANUARY 1952

How to Select Steels for Low Temperature Service

by **JOHN L. EVERHART**, Associate Editor, Materials & Methods

Toughness, as indicated by embrittlement temperature, and part design critically influence performance of steels in subfreezing applications.

● THE PROPERTIES OF materials at low temperatures have become increasingly important in recent years because of the expanding use of such temperatures in the chemical processing industries and the need for the operation of military equipment and aircraft under sub-freezing conditions. Temperatures reached in such applications range from outdoor winter exposure downward to within a few degrees of absolute zero. Military equipment and aircraft operate at the upper end of the range.

In general, the lowest ground temperature reached is about —65 F, although occasional temperatures as low as —90 F have been reported. In the upper air, at altitudes reached by aircraft, the lowest ambient temperature is about —130 F. Some authorities believe that no part of the plane reaches this temperature, however, because of aerodynamic heating. In the chemical field the range is much greater, extending from the relatively mild temperatures required for drying pharmaceuticals and the quick-freezing of foods, through those necessary for dewaxing lubricating oils, processing butyl rubber, gas storage and the separation of oxygen and nitrogen to the liquefaction of helium.

Steels which are suitable for applications in the upper part of the range might be unsuitable for service at the extremely low temperatures. Conditions of loading also determine the usefulness of materials for such service. Under conditions of static loading, steels which are suitable for room temperature service can often be used safely at quite low temperatures. However, under conditions of shock loading, vibration or restraint, the tendency of some steels to become embrittled places a limit on their low temperature applications.

In general, the strength and hardness of steels increase with falling temperatures. The ductility as measured by the tension test shows little change or decreases slightly down to temperatures near —250 F, below which there may be a sharp drop. Under shock loading in the presence of a notch, as in the Charpy impact test, steels act in quite a different fashion. Some retain their toughness to low temperatures, others become embrittled at temperatures only slightly below freezing.

The temperature at which such embrittlement occurs was called by early investigators "the transition temperature." This was an unfortunate choice of terminology, for it is now generally recognized that the so-called transition temperature can vary widely in a single heat of steel since the temperature at which embrittlement occurs depends on the testing method. It has been found, however, that in general, steels will show the same order of embrittlement temperatures under different methods of testing.

Since the Charpy impact test is quite a sensitive indicator of temperature effects, it has been applied widely to investigate low temperature properties. Although the results obtained are merely qualitative and supply no information directly useful in design, some correlation was found between Charpy tests and full-size plate tests in an investigation into the failure of welded ships. These results encourage the thought that, as a larger background of experience is established, it may be possible to apply the results of the Charpy test more fully in the future.

The selection of steels for low temperature service involves both metallurgical and mechanical factors. Among the former, melting procedure, chemical composition, the finishing temperature for hot rolling, internal structure, grain size and heat treatment influence the temperature at which the steels become embrittled. Among the latter, design of the part, presence or absence of notches, restraint, type of loading, size and shape influence the manner of failure of a material.

For winter service, military equipment must be built to withstand temperatures as low as —65 F. (U. S. Army photo)

Mechanical Properties of Some Steels at Low Temperatures

Composition	Condition	Temp. F	Yld. Str., Psi	Ten. Str., Psi	Elong., %	Red. of Area, %	Fatigue Str., Psi	Mod. of Elasticity (Tension) Psi	Impact Str.	Type Specimen	Source
0.010 C	Normalized at 1700 F	Room	45,000	69,000	39	69	......	....	....	CK	Crafts & Offenhauer
0.65 Mn		−106	.....	.....	....	....	......	....	53		
0.23 Si		−148	.....	.....	....	....	......	....	60		
0.61 N		−184	.....	.....	....	....	......	....	42		
0.68 Cr		−229	.....	.....	....	....	......	....	39		
0.48 Cu		−292	.....	.....	....	....	......	....	4		
0.05 Al Sol.											
0.002 Al Insol.											
SAE 2330											
0.28–0.33 C	Normalized	77	88,700	109,000	12.5	50	59,000	26,900,000	18.6	CK	Fontana & Zambron
0.60–0.80 Mn		−108	105,000	121,000	11.5	46	63,000	28,100,000	5.6		
3.25–3.75 Ni		−314	141,000	163,000	13.0	33	112,000	30,800,000	3.0		
	Oil quenched from 1500 F, tempered 925 F	77	139,000	145,000	17.5	59	75,000	29,200,000	35.8		
		−108	146,000	159,000	20.5	56	95,000	30,000,000	30.0		
		−314	186,000	186,000	20.5	40	125,000	31,600,000	16.8		
NE 8630											
0.27–0.33 C	Normalized	77	80,500	89,800	16.0	58	46,000	27,100,000	29.0	CK	Fontana & Zambron
0.70–0.90 Mn		−108	91,500	104,000	18.5	57	58,000	28,900,000	4.4		
0.48–0.67 Ni		−314	134,000	150,000	11.5	28	93,000	31,700,000	3.4		
0.49–0.56 Cr											
0.20–0.35 Si	Oil quenched from 1500 F, tempered 850 F	77	121,000	142,000	15.5	59	70,000	29,800,000	39.1		
0.18 Mo		−108	127,000	154,000	17.0	57	80,000	31,100,000	21.1		
		−314	166,000	192,000	12.5	50	125,000	32,300,000	5.0		
AISI 2800											
0.10 C	Normalized 1650 F, normalized 1450 F, tempered 1050 F	77	87,800	117,000	25	62	73,000	27,600,000	44.0	CK	Fontana & Zambron
0.77 Mn		−108	88,000	136,000	27	60	80,000	28,300,000	41.4		
0.23 Si		−314	133,000	170,000	30	55	100,000	29,900,000	22.6		
8.60 Ni											
0.05 Al											
0.05 Ti											
AISI 322											
0.07 C	Normalized 1900 F, aged 1000 F	77	176,000	182,000	12.5	54	95,000	29,000,000	13.5	CK	Fontana & Zambron
0.43 Mn		−108	198,000	203,000	9.5	55	120,000	30,400,000	4.1		
0.53 Si		−314	237,000	241,000	8.0	38	155,000	31,600,000	1.4		
6.5 Ni											
17.0 Cr											
0.12 Al											
0.37 Ti											
AISI 304											
0.054 C	Cold-rolled	77	149,000	212,000	12.0	54	110,000	23,600,000	24.7	CK	Fontana & Zambron
0.49 Mn		−108	180,000	241,000	14.5	62	125,000	25,500,000	34.5		
0.42 Si		−314	189,000	296,000	23.5	45	155,000	27,700,000	30.3		
18.5 Cr											
8.82 Ni											
AISI 304											
0.08 C Max	Annealed	32	34,000	130,000	55	68	......	....	110	IZ	Allegheny-Ludlum
18.0–20.0 Cr		−40	34,000	155,000	47	64	......	....	110		
8.0–11.0 Ni		−80	34,000	170,000	39	63	......	....	110		
		−320	39,000	246,000	32	55	......	....	110		
AISI 316											
0.10 C Max	Annealed	32	39,000	90,000	60	75	......	....	110	IZ	Allegheny-Ludlum
16.0–18.0 Cr		−40	41,000	104,000	59	75	......	....	110		
10.0–14.0 Ni		−80	44,000	118,000	57	73	......	....	110		
2.0–3.0 Mo		−320	70,000	180,000	46	64	......	....	110		
AISI 410											
0.15 C Max	Annealed	32	89,000	115,000	24	69	......	....	40	IZ	Allegheny-Ludlum
11.5–13.5 Cr		−40	90,000	122,000	23	64	......	....	25		
		−80	94,000	128,000	22	60	......	....	25		
		−320	148,000	158,000	10	11	......	....	5		
AISI 430											
6.15 C Max	Annealed	32	40,000	69,000	37	72	......	....	20	IZ	Allegheny-Ludlum
14.0–18.0 Cr		−40	41,000	76,000	36	72	......	....	10		
		−80	44,000	81,000	36	70	......	....	8		
		−320	87,000	90,000	0	4	......	....	2		
0.07 C	Cast	70	37,500	73,500	59	....	......	....	82	CK	Juppenlatz
19.32 Cr		−320	79,500	162,000	33	....	......	....	61		
9.5 Ni											

NOTES: CK: Charpy impact specimen with Keyhole notch.
IZ: Izod impact specimen with "V" notch.

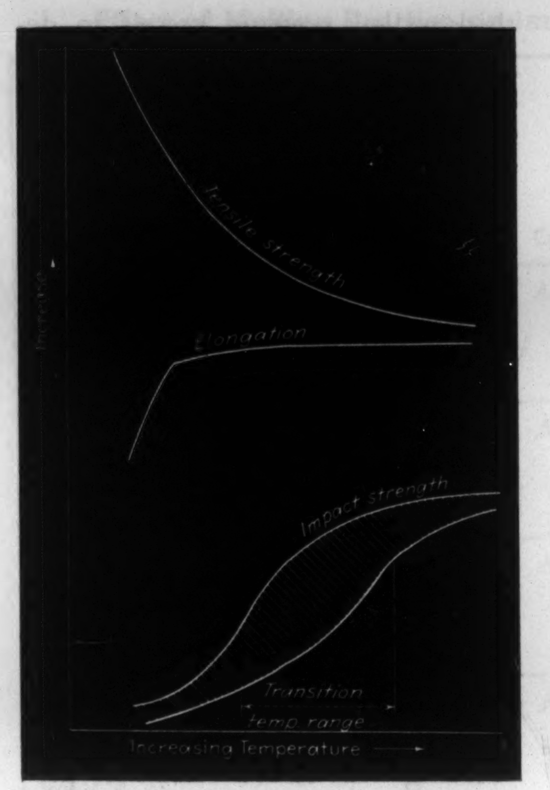
Metallurgical Factors

Investigations at low temperatures have shown that the face-centered cubic metals retain their ductility and toughness to the lowest temperatures which have been studied, while the body-centered cubic and hexagonal close-packed structures are embrittled at some temperature. These properties appear to be characteristic of the various crystal structures. The austenitic stainless steels have a face-centered cubic structure and retain their toughness down to temperatures approaching absolute zero. Some qualification of this statement is necessary because the presence of sigma-phase or precipitation hardening constituents make these steels partially unstable and may cause brittleness. For optimum results, low-carbon austenitic steels quenched to retain the carbides in solution are desirable.

If it were economically practical to employ the austenitic steels for all low-temperature applications requiring steel, no particular difficulties would be encountered. However, this is much too expensive a procedure to be tolerated, and the ferritic steels must be used in many applications. The ferritic steels, having the body-centered cubic structure, are sensitive to embrittlement at some temperature. As a matter of fact, some of these steels have transition temperatures above room temperature and are brittle at 32 F.

Since the ferritic steels are the materials which must be used, for reasons of economy, over an important part of the low temperature range, they have been investigated quite widely and a number of the metallurgical factors which influence the tendency toward embrittlement have been established. Although they are considered separately in the following paragraphs, it must be emphasized that they are interrelated.

Melting practice has a considerable effect on the embrittling temperature. In the ferritic steels, thoroughly killed steels containing residual aluminum have the lowest transition temperatures, while ordinary bessemer steels have the highest. Between these two extremes, in order of decreasing toughness, are the semi-killed steels with aluminum additions, the silicon-killed steels, and the rimmed steels. The recently modified bessemer steels have not been investigated sufficiently to be included in this classification, although some tests have indicated that these steels have transition temperatures as low as the fully killed steels mentioned previously



Schematic diagram showing how temperature affects strength and toughness.

The effects of composition have not been fully established. In ordinary carbon steels, low carbon content favors low transition temperatures. However, the quantity of carbon present may be less important than its distribution. A fully dispersed form of iron carbide is least damaging. Phosphorus and sulfur should be held as low as possible. Manganese up to $1\frac{1}{2}\%$ appears to lower the transition temperature. Beyond that quantity manganese can be harmful, particularly in steels which are sensitive to temper brittleness. Silicon up to about 0.25% appears to be beneficial. However, high silicon seems to be detrimental in both carbon and low alloy constructional steels.

Although nitrogen is generally credited with raising the transition temperature, recent work at the National Bureau of Standards indicates that the effect of nitrogen on the transition temperature depends on its form in the steels. In this work it was found that, if the nitrogen was present as aluminum nitride, the transition temperature was lowered slightly with increasing nitrogen content.

In the low alloy steels, nickel, chromium, molybdenum and copper within the solubility range are generally credited with having a beneficial effect. However, one authority believes that chromium and molybdenum are not beneficial in low alloy steels in the as-rolled condition. The tendency of aluminum and titanium to combine with oxygen, nitrogen and sulfur and to promote fine grain size is helpful in promoting low temperature toughness.

A number of investigators have shown that fine-grained steels have lower transition temperatures than coarse grained steels at any strength level. Steels of mixed grain size are intermediate. It has been indicated that the overheating of steel, even though the grain-size has not been appreciably altered in appearance, can cause a precipitous drop in impact strength at low temperatures.

For the ferritic steels, fully hardened and tempered martensitic structures have the lowest transition temperatures. To avoid temper brittleness, the steels should be water quenched from the highest tempering temperature which will yield the required strength. If the steel has not been hardened throughout, mixed structures will be obtained accompanied by a rise in the transition temperature. The next most favorable structure is obtained by normalizing and tempering. Slowly cooled steels containing lamellar pearlite have the highest transition temperatures of the heat treated steels. Steels in the as-rolled condition have shown highly erratic behavior.

Mechanical Factors

Design considerations for low temperature service differ from those applicable to normal temperature service only in degree. Engineers are fully aware that sharp fillets should be avoided in equipment to be used at room temperature to minimize

At the highest altitudes reached by modern aircraft, the ambient temperature may be —130 F. (Aluminum Co. of America)

The shock loading involved in gun firing must be given careful consideration in designing for low temperature service. (U. S. Army photo)

stress concentrations. Because of the increasing sensitivity of ferritic steels to embrittlement with falling temperatures, the elimination of sharp fillets in designing for low temperature service is even more necessary. The design of a part can influence the residual stresses after heat treatment, and such factors must be considered in designing for service at any temperature at which heat treated steel is to be used.

Since the ferritic steels become notch-sensitive at low temperatures, notches and sharp changes in section should be avoided. Surface imperfections, such as scratches and tool marks, can be the points at which failure begins in severely stressed parts, the effect being more pronounced at low temperatures than at normal temperatures because of the reduced ductility of the steel.

The section size of the part has a considerable effect on the type of failure. Thin sections tend to fail in a ductile manner while heavy sections tend to be brittle, other factors being the same. These effects are due entirely to the geometry of the section, there being greater restraint in the heavy section than in the light section. Again, if the steel is able to flow freely, near an advancing crack, the fracture tends to be ductile. If the metal is constrained, as in a heavy section by the surrounding mass of rigid metal, the crack tends to proceed rapidly and the fracture is brittle. It is well-known that in testing thick-walled pressure vessels to destruction, brittle fractures occur, while in testing similar vessels built up of layers of thin strip, the failures are ductile.

The type of loading affects the choice of steels also. Under conditions of high stress concentration and high straining rates, steels having lower embrittlement temperatures than those required for less severe service must be used.

Welding

Factors which influence the ductility of welds include design, thermal effects, variations in the base or weld metal, and dissolved gases. The welding of low-carbon steel with uncoated electrodes yields welds which are notch-sensitive at low temperatures. Welding with coated electrodes produces welds which frequently have notch-sensitivity equivalent to that of the base metal. Satisfactory resistance to notches can be obtained generally by using the so-called low-hydrogen electrodes. The structure and hardness in the heat-affected zone will generally be satisfactory unless extremely high energy inputs have been used. These may produce unusual microstructures in the zone which are notch sensitive.

For alloy steels quenched and tempered before welding, either ferritic or austenitic electrodes can be used. The low-hydrogen coated electrode assists in the production of crack-free weldments. The resistance to notches of such welds may be lower than that of the plate. Austenitic weld metals remain ductile to very low temperatures. However, the use of austenitic electrodes to join ferritic steels may give a brittle transition zone, an effect which can be reduced by using 25-20 electrodes instead of the 19-9 type. For extremely low temperature service, austenitic steels welded with austenitic electrodes are used.

The performance and strength of a welded structure depends on a number of factors, including type of electrode, preheating, postheating, and welding procedure. Generally, the welding operation impairs the properties of the plate. Among reasons which have been advanced are: effect of heat input on the metallurgical structure, composition and hydrogen content of the weld metal, and stresses resulting from the welding operation. It has been suggested that preheating is effective in producing notch-toughness, while postheating in 1150 F is said to be especially effective in restoring the ductility of the plate after welding.

Selection of Steels

No specific recommendation can be made under the present state of knowledge for the selection of steels for low temperature service. Such selection depends on the stress distribution, strain rate and temperature range to be considered. However,

Effect on Steels of Sustained Stress at –320 F (Armstrong & Miller)

Composition	Condition	Charpy Keyhole-Notch Impact Strength Ft-Lb Unstressed	Stressed 30,000 Psi	Time Under Stress
AISI 2800 0.10 C 0.77 Mn 0.28 Si 8.56 Ni	Plate, double normalized and reheated to 1050 F	27	22	14 days
	Butt-welded with Type 310 electrodes, air-cooled from 1050 F after welding	24	22	14 days
AISI 310 0.11 C 1.51 Mn 0.42 Si 21.64 Ni 27.22 Cr	Plate, annealed	49	48	13 days
	Butt-welded, as welded	25	28	13 days
AISI 316 0.08 C 1.54 Mn 0.56 Si 12.01 Ni 17.65 Cr 2.74 Mo	Plate, annealed	52	59	13 days
	Butt-welded, as welded	17	22	13 days

some suggestions are possible.

For service in the range from room temperature to —25 F, ordinary carbon steels should be suitable. It should be recalled in making a selection that, other factors being equal, low carbon steels have the lowest embrittling temperatures. At the lower end of the range under severe service conditions, fully killed steels containing residual aluminum might be required since these steels have lower transition temperatures than the semikilled steels.

For service in the range —25 to —100 F, low carbon-low alloy steels or the AISI-SAE standard steels can be used. Steels sensitive to temper embrittlement should be avoided. These include some of the manganese and chromium steels. The nickel, chromium - molybdenum, chromium - nickel-copper and nickel-chromium-molybdenum steels are suitable for applications in this range.

Steels for service in the range from —100 to —200 F are more limited. Of the ferritic materials, the nickel steels, particularly that containing 8½% nickel, chromium-nickel-copper, nickel-molybdenum and chromium-molybdenum steels can be used. However, they must be well-made clean steels and should be used, preferably, in the tempered martensitic condition. In this range most of the austenitic stainless steels are applicable.

Although certain of the nickel steels, particularly that containing 8½% nickel, can be used with caution below —200 F, this field is generally reserved for the austenitic steels. If the constituents are adjusted to obtain a stable, low-carbon alloy, the resistance to impact is excellent down to the lowest temperatures which have been investigated.

Effect of Melting Practice on Impact Strength of Carbon Steels

Composition	Condition	Temp F	Charpy Keyhole Notch Impact Str., Ft-Lb	Source
SAE 1010 Bessemer Structural	As rolled	148 68 32 0	37 26 4 3	Epstein
0.10 C Open Hearth Structural	As rolled	148 68 32 0	36 32 26 3.5	Epstein
0.10 C Izett (Al Killed)	As rolled	68 0 −40 −80	47 42 35 5	Epstein
0.08 C 0.38 Mn 0.79 P 0.037 S 0.005 Si	As rolled	75 0 −25 −50	24 3 3 2	Wilder
Capped Bessemer (Austenitic Grain Size 2–4)	Normalized at 1650 F	75 0 −25 −50	6 3 3 2	
0.07 C 0.45 Mn 0.006 P 0.020 S 0.005 Si	As rolled	75 0 25 −50	40 4 4 3	Wilder
Capped Open Hearth (Austenitic Grain Size 0–3)	Normalized at 1650 F	75 0 −25 −50	21 5 4 3	
0.14 C 0.54 Mn 0.074 P 0.022 S 0.18 Si Deoxidized Acid Bessemer (Austenitic Grain Size 7–8)	Normalized at 1950 F	75 0 −25 −50	46 35 33 30	Wilder
0.27C 0.52 Mn 0.016 P 0.025 Si 0.22 Si Si Killed Open Hearth (Austenitic Grain Size 1–3)	Normalized at 1950 F	75 0 −25 −50	24 4 3 2	Wilder
0.24 C 0.86 Mn 0.017 P 0.021 S 0.23 Si Si-Al-Killed Open Hearth (Austenitic Grain Size 6–7)	Normalized at 1950 F	75 0 −25 −50	45 35 35 28	Wilder

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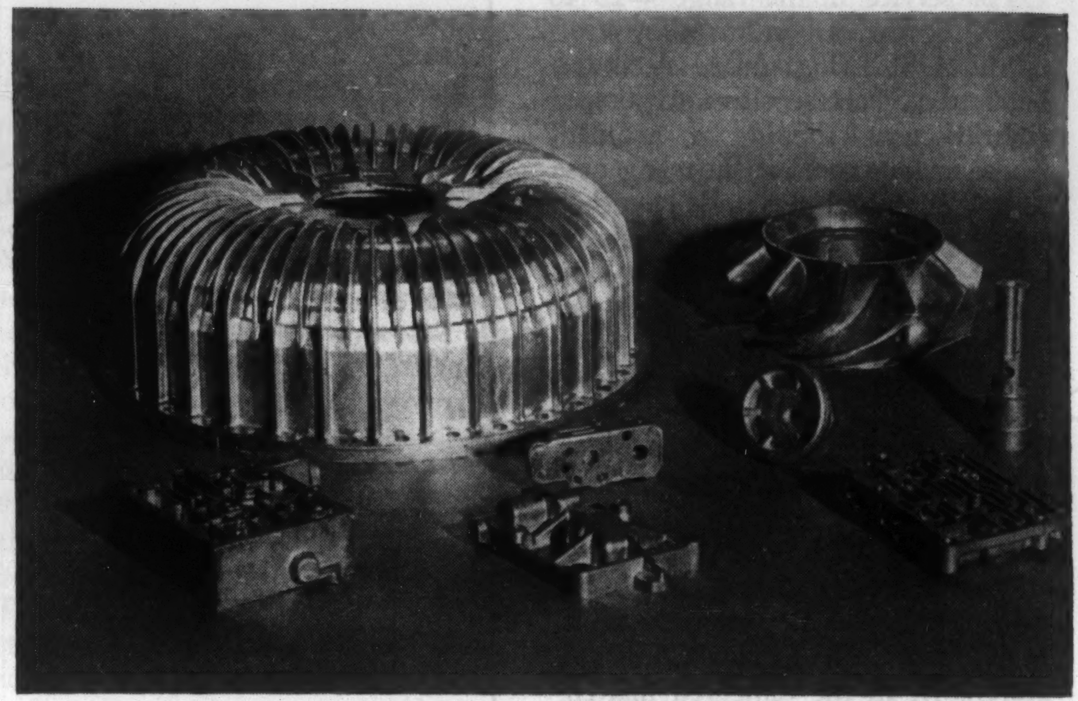
Aluminum Alloy Die Castings Used in Complex Automotive Parts

by **T. C. DU MOND**, Editor, Materials & Methods

Ford engineers chose aluminum and die casting for their automatic transmission because this combination of material and method met the requirements of lightness, good heat dissipation, fine finish, and close dimensional tolerances on complicated details.



Here are several of the more than 30 aluminum die castings which are used in the new Ford automatic transmission units. The parts, as photographed, have not been machined. All have been degated and heavy flash has been removed.

● THE NEW AUTOMATIC transmissions now appearing on the Ford Motor Co. line of automobiles are of considerable interest to engineers. Not the least of this interest is centered upon the extensive use of aluminum die castings in the assembly. More than 30 separate parts of the transmission are aluminum die castings. It is believed that this is the greatest use of die castings ever made in a comparable mechanism.

Engineering of the ingenious transmission was a joint project of Ford Motor Co. and Borg-Warner Corp. Many of the complex die castings are manufactured in the Fayetteville, N. Y., and Cleveland, Ohio, plants of Precision Castings Co., Inc.

Because of design details of the parts, which are highly complex, the original intention was to make many of the pieces as aluminum plaster mold castings. The needs included: fine finish, close dimensional tolerances, thin walls and some sharp corners. In addition, plaster mold castings or some comparable method of producing the parts would permit more complex parts to be made than would have been possible by simpler production methods. Because most of the requirements could be met by die casting, dies and techniques were developed so that the present production method could be adopted.

Transmission Parts

In all, nine separate parts of the unit are die cast by Precision Castings Co. Most of these parts involve highly complicated interlocking coring. Thus, considerable die making skill and superior casting techniques are required. Parts made include a stator weighing 1.423 lb; an impeller cover weighing 9.087 lb; several valve parts, a piston and a sleeve clutch oil collector. The latter parts range in weight from 0.134 lb up to 1.307 lb.

All die castings are produced as close to final size as is economical and practicable. The net result is that little machining is required on any of the parts. In Precision's plants the parts are degated and heavy flash is removed in trimming operations. Prior to assembly thin machining cuts are taken on some surfaces to achieve final dimensions. Some boring and facing cuts also are required on a few of the parts. Actually, tolerances held in the die casting operation are closer than had been anticipated.

Of all these parts, by far the most complicated as far as die casting is concerned is the stator. This part required a die on which the entire outer portion is movable. By making it possible to move the outer portions in and out, it became possible to cast eleven radial-helical fins accurately to final shape. The complex die is as large as that for any other part in the assembly, although the part itself is only of moderate size.

The impeller cover, the largest part, is an interesting die casting because of the multitude of thin cooling fins

These valve body parts show why intricate interlocking coring was necessary in the dies. At the left is shown how the parts are gated. The right-hand piece has been trimmed. The internal surfaces of these parts are anodized for smoothness and wear resistance.

required. Internal grooves in the cover are used as-cast to hold stamped steel blades in place.

Die casting and die making techniques came into full play in the production of the valve parts for the transmission unit. Most of these parts require considerable interlocking coring. Dimensional tolerances on these parts are extremely close. The valving particularly must be accurate to control a precise flow of transmission oil through the unit. The valve bodies must not only be accurately made, but also retain this accuracy indefinitely. Glassy smoothness and wear resistance on the inner surfaces of the valve are attained by anodizing.

Aluminum Used

Aluminum had been selected as the material for these parts when they were first planned as plaster mold castings. When the parts were changed to die castings, aluminum was retained as the material for several reasons.

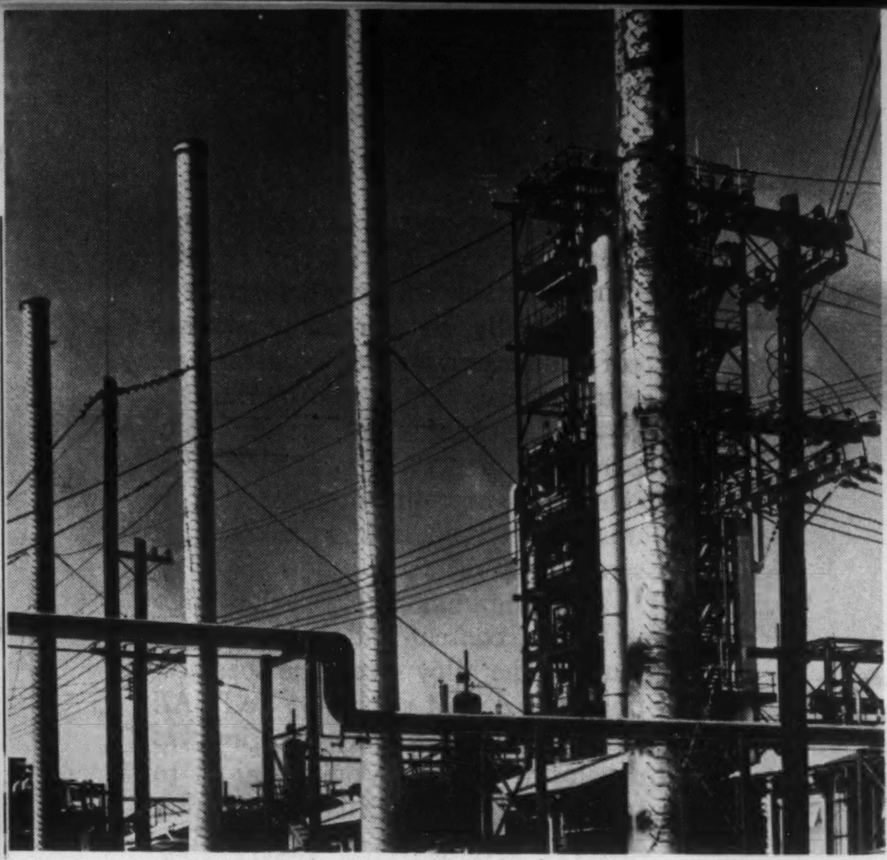
Two of the principal reasons for deciding to use aluminum are the lightness of the metal and the fact that aluminum has good heat conducting and dissipating characteristics. Even though the die casting cycle for aluminum is somewhat slower than for some other die casting alloys, the present price differential between aluminum and the other materials makes aluminum less expensive. However, this was not a deciding factor in choosing aluminum.

As an example of how the two cited characteristics of aluminum were used to advantage, we can take the impeller cover. In addition to acting as a cover, this part serves as a flywheel when the transmission is in use. Therefore, it is important that there be as little inertia to overcome as is possible when the unit starts to move. Second, the impeller is filled with oil which is inclined to heat up during functioning of the transmission. The heat conductivity of the aluminum carries away much of the heat and dissipates it through the fins on the outside surface of the cover.

Naturally, the corrosion resistance of aluminum is used to advantage. An auxiliary benefit lies in the lack of resonance of aluminum as compared to zinc, cast iron or steel. Because of low resonance, the unit is more quiet than if it were made of some other metal.

The aluminum alloy used is high in silicon content and is strong and tough. The alloy meets the specifications for ASTM alloy B85 and SAE alloy E-308. Originally the alloy was developed during World War II to provide a high strength alloy that could use high grade scrap. The alloy has an as-cast tensile strength of 38,000 psi and a hardness of approximately 78 Bhn. Corrosion resistance, color and machinability are all rated as good, and the alloy has good casting properties.

Here an operator removes a die cast impeller cover from the die casting machine.



Four 50-ft ethylene plant powerhouse stacks after 18 months' exposure to high temperatures and corrosive atmospheres. Three at left are coated with silicone coatings, one at right with conventional heat-resistant paint. (Dow Chemical Co.)

The silicone-based aluminum paint on exhaust muffler at left shows none of the effects of 500 F temperatures evident on the conventionally coated muffler after an exposure of 18 months. (Dow Chemical Co.)

Silicone Coatings Protect Metals

Longer service life, because of superior heat and weathering resistance, often justifies the use of silicone finishes in place of lower-priced conventional coatings.

by C. E. ARNTZEN and R. D. ROWLEY,

Materials Engineering Dept., Westinghouse Electric Corp.

● SILICONE VEHICLES for baking enamels offer the possibility of securing high temperature and weather resistant flexible coatings not previously available. Present indications from tests are that silicone enamels are far superior in heat and weathering resistance to any of the conventional organic coatings. In addition, they exhibit excellent resistance to discoloration. They can be applied in the conventional manner by dipping or spraying. Their baking temperatures (300 to 400 F), however, are somewhat higher than those required for organic coatings.

The silicone vehicle resins, like silicone rubber, depend on the silicon-oxygen-silicon "back bone" for their remarkable thermal stability. However, the ratio of organic groups to silicon atoms in the silicone vehicles is less than that in the silicone rubbers. This permits more cross linkages and produces a material with thermoset properties. The silicone vehicles are alkyl-aryl-copolymers and, therefore, can be produced with various degrees of flexibility, thermoplasticity and mechanical strength by varying the ratios of the alkyl-aryl and the organic groups to the silicon atoms.

Various types of silicone resins are available for use in the formulation of heat and weather resistant coatings. Table I lists the general characteristics and properties of the silicone resins available from the Dow Corning Corp. These resins can be blended to give the properties desired.

These silicone resins are readily soluble in aliphatic and aromatic hydrocarbon solvents forming solutions low in viscosity at high resin concentrations. They wet pigments readily, and many of the common pigments can be used with them. Silicone enamels of almost any shade can be formulated by adding the proper pigment. Pigment dispersal can be done with roller, pebble and ball mills, without any special equipment.

Heat Resistance

Probably the outstanding property of silicone finishes is their excellent resistance to heat. While the silicones will not withstand as high temperatures as porcelain enamels, they do permit the attainment of much higher temperatures than possible with straight organic finishes. The pigment used with silicones must be carefully selected since it must resist baking as well as any subsequent high tempera-

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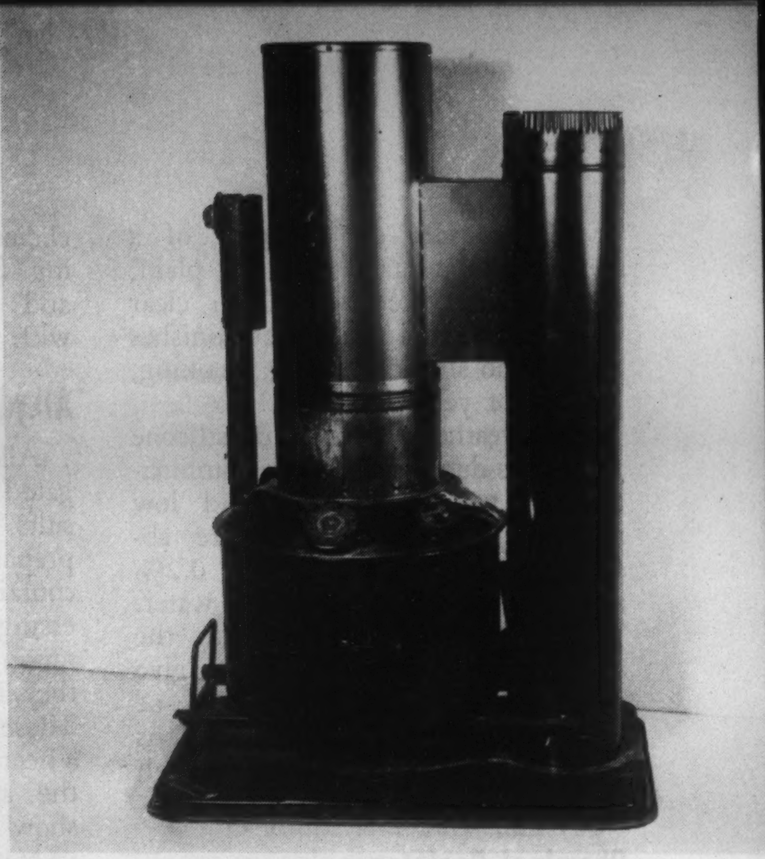
Modified silicone aluminum paint is said to increase the life of the finish on this Autocar diesel truck exhaust stack from 30 min to 30 days.



The front portion (left, in picture) of this space heater was painted with conventional black stove finish and the other half was painted with a silicone-base enamel. Heater was operated for 4 hr. Temperature at base, 800 F; at top, 553 F. (Dow Corning Corp.)

Against Severe Service Conditions

tures, and also must not gel the resin solution or reduce the life of the finish. Most pigments are inorganic. The most heat resistant silicone finishes are those pigmented with the normal percentage of aluminum powder. These finishes will withstand 930 F for a few hours and 750 F for as much as 100 hr before there is considerable film failure and loss of adhesion.

Test panels coated with DC801 pigmented with aluminum powder show no checking after 2800 hr aging at 480 F. Similar tests show slight checking after 700 hr aging at 480 F when DC803 is the vehicle, checking after 900 hr with DC804 as the vehicle, and no checking after 2800 hr with DC802 as the vehicle.

The best white enamels are those containing titanium oxide extended with calcium sulfate. Such enamels have been held at 500 F for 500 hr without cracking or checking. Other good white pigments are lithopone and antimony oxide with enough titanium oxide to provide the required opacity.

Colored pigments that have been used successfully with silicone resins are red iron oxide, cadmium red, lithol and toluidine reds (but not for use above 300 F), phthalocyanine blue, iron blue, ultramarine blue, chrome green, chrome yellow, and lead molybdate.

Silicone enamels are available that have excellent purity of color and tint due to absence of color in the resin and freedom from resin discoloration at elevated temperatures. Even on failure at high temperatures, no discoloration of the resin or loss of glass is apparent, evidence of film failure being cracking or checking, and loss of adhesion.

Weathering

The weather resistance of silicone finishes indicates unusual durability. A white enamel showed no evidence of checking, cracking, chalking or loss of glass after 4 yr of exposure to weathering. Alkyd resins faded and chalked badly under the same conditions. Similar tests performed by Dow Corning indicate that after 4½

Table I—Silicone Resins for Coatings

Silicone	Solids (%)	Viscosity (Centipoises)	Drying Time (Hr)*	Typical Uses
DC801	60	100–300	4 at 285 F	Paint vehicle, dark and soft and flexible
DC802	50	100–200	4 at 390 F	Paint vehicle, light and soft
DC803	50	100–300	1 at 285 F	Paint vehicle, light and hard
DC804	60	30–100	1 at 285 F	Paint vehicle, hard and tough

**In some cases, although the film is dry, it is not thoroughly cured.*

yr of exposure on the roof of a building in a large chemical plant, test panels coated with both clear and pigmented silicone finishes showed no sign of crazing, chalking, peeling or yellowing.

The weather-proofness of silicone finishes is due in part to the combination of water repellency and low moisture absorption. Moisture absorption is on the order of 0.2% after 168 hr of immersion in water. These properties contribute to the ability of the silicone finishes to give protection against the rusting of metal surfaces in humid conditions even after long exposure to high temperatures.

Chemical Resistance

In general, the silicone resins used for coating have good chemical resistance. When formulated with resistant pigments, tests show that they are resistant to 3% concentrations of alkalies and of mineral acids at 100 F for over 100 hr. For many applications, they are also resistant to salts, oils, alcohols, and to staining by iodine, mustard, grape juice, mercurochrome and tomato juice, but are inferior to alkyds and melamines in resisting hydrocarbon solvents.

Table II gives in greater detail the chemical resistance of a silicone coating formulated from 60% DC804 and 40% DC802 and pigmented with titanium dioxide.

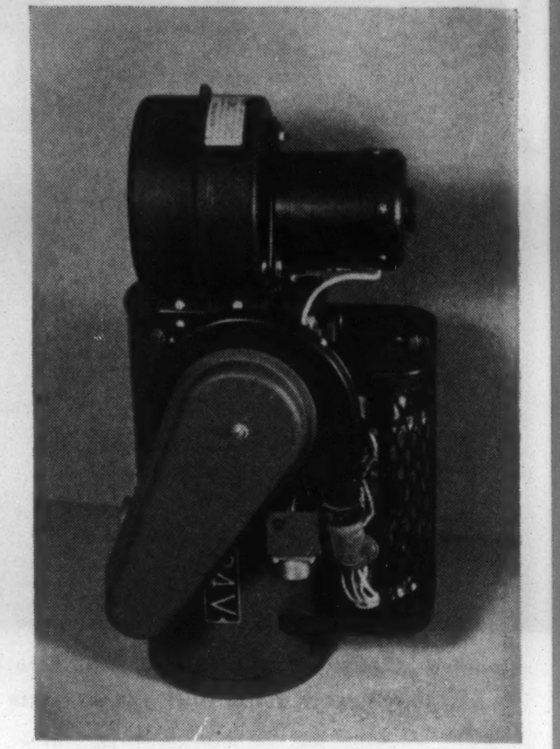
Alkyd Silicones

Alkyd silicones are being investigated and have shown promising results. The alkyd silicones have been prepared by the addition of a silicone containing material during the processing of the alkyd and also by mere mixing of silicones and alkyds after they have been prepared separately. These modified silicone resins possess a heat resistance intermediate between the alkyds and silicones and also show some improvement in adhesion to metal surfaces over silicones alone. Several concerns are marketing silicone alkyds and silicones for mixing the alkyds from which finishes can be produced.

Applications

Silicone finishes are used, at present, for special applications where heat and certain types of chemical resistance are essential. Typical uses are for coating ovens, smoke stacks, exhaust manifolds, kitchen ranges, furnaces, boilers, motors, and chemical plant equipment. As costs become lower through increased production and by modification with other resins, many other applications will be possible.

The field of silicones is still in its infancy, and lower prices due to improved manufacturing techniques can be expected in the future, along with improvements in their physical and chemical properties. Although it does not appear that the prices of silicones will soon become low enough to be competitive with cheap naturally occurring materials or material prepared from coal tar and petroleum derivatives, their unusual properties undoubtedly will continue to increase their applications, especially where their added cost is over-shadowed by savings which they can afford in other respects. As these materials continue to be investigated for other uses, their limitations will be revealed and many overcome so that the silicones of tomorrow will be better and more widely used than those of today.



A modified silicone maintains the Army's olive drab on this heater at 500 F. (Southwind Div. of Stewart Warner Corp.)

Table II—Chemical Resistance of a Silicone Coating Containing 60% DC804 and 40% DC802 Pigmented with TiO_2

Chemical Reagent	Rating after Immersion at 70 F for			Rating after Immersion at 100 F for		
	3 Hr	20 Hr	100 Hr	3 Hr	20 Hr	100 Hr
Acetic Acid, 2%	E	E	E	E	E	E
Acetic Acid, 100%	G	O	O	O	O	O
Hydrochloric Acid, 2%	E	E	E	E	G	G
Hydrochloric Acid, 10%	E	E	E	E	G	F
Nitric Acid, 2%	E	E	E	E	G	O
Nitric Acid, 10%	E	E	E	E	G	O
Phosphoric Acid, 2%	E	E	E	E	E	E
Phosphoric Acid, 10%	E	E	E	E	E	E
Sulfuric Acid, 2%	E	E	E	E	G	G
Sulfuric Acid, 10%	E	E	E	E	E	O
Sodium Hydroxide, 2%	E	E	G	E	E	O
Sodium Hydroxide, 10%	E	E–x	E–x	E–x	E–x	O
Butyl Alcohol	E	E	E	E	E	E
Kerosene	E	E	E	E	E–x	E–x
Methyl Ethyl Ketone	O	O	O	←Not Tested→		
Turpentine	P	O	O	←Not Tested→		
Sodium Chloride, 2%	E	E	E	E	E	E
Sodium Chloride, 10%	E	E	E	E	E	E
Sodium Polysulfide, 2%	E	E	G	E	G	P
Sodium Polysulfide, 10%	E	O	O	←Not Tested→		
Linseed Oil	E	E	E	E	E	E
Oil SAE 30	E	E	E	E	E	E
Petroleum Grease	E	E	E	E	E	E
Clorox	E	E	E	E	E	P
Distilled Water	E	E	E	E	E	E
Hydrogen Peroxide	E	E	E	E	E	E

E—Excellent; G—Good; F—Fair; P—Poor; O—Failure; E–x—Panel attacked at edge, but film intact.

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How to Choose Spring Materials

by **M. GERARD FANGEMANN**, Manager, Spring Div., John Chatillon & Sons

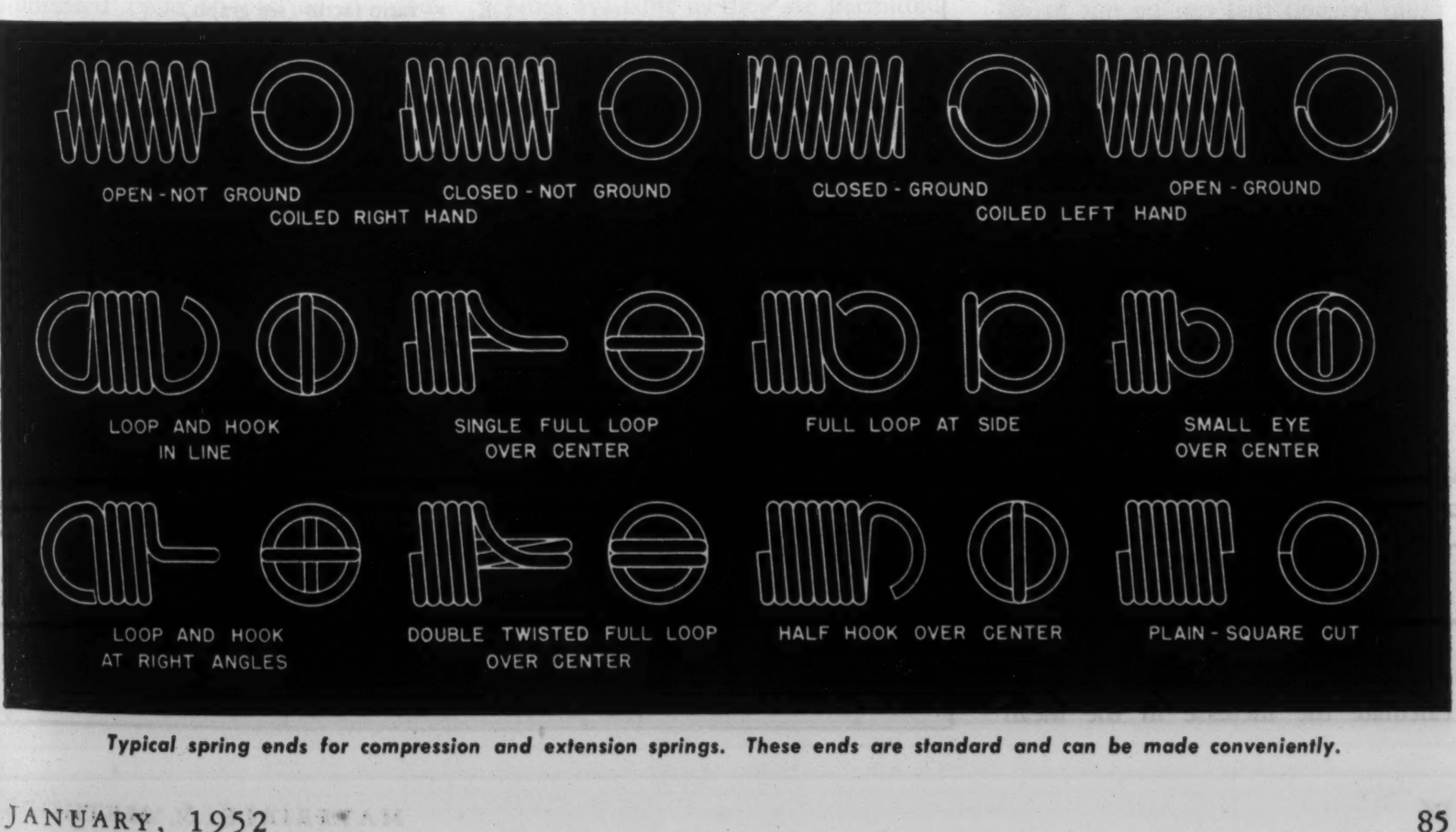
Proper choice depends on several considerations the first of which is determining the correct type and design. This, the first of a two-part article, describes the available spring types. The second part will cover in detail the principal spring materials.

● SPRINGS ARE ALMOST never made by the equipment manufacturers who put spring components into their products. Springs are bought to meet specific problems in product design and manufacture. To choose a spring component intelligently, the engineer must first know the main type of springs available and what each will do efficiently. He may require a compression spring, an extension spring, a torsion spring, a spiral spring, a wire form or a spring washer. After choosing the proper type spring for the application, the engineer picks the best material and the most economical tolerances that can be allowed.

Close coordination and cooperation between the customer, the manufacturer and the engineers involved is extremely important. A spring design that meets performance specifications but cannot be processed because of manufacturing difficulties inherent in the design, or because of material scarcity, is of little use to the customer. Many times customers specify unnecessarily close tolerances that only add to the manufacturing costs and, in some instances, even make the spring impossible to manufacture. The spring engineer considers each factor in the choice of a component separately, but his final decisions are based on the combined effects of all the factors. Close communication between the spring engineer and the manufacturer is a must if all the factors are to be evaluated correctly.

The choice of a material for a spring application depends mainly on the operating conditions. The highest stressed springs are usually made from music wire or chromium-vanadium steel, whereas stainless steel, phosphor-bronze and beryllium copper are suitable for corrosion resistant springs. Inconel is adaptable for springs up to 700 F, and Inconel-X to approximately 15 to 1800 F. Temperature compensated springs are becoming increasingly important and are usually manufactured from Iso-Elastic alloy or Ni-Span-C. Other conditions—fatigue, creep or drift, straight line, hysteresis, etc.—should also be taken into consideration when spring materials are chosen. The customer's requirements usually limit the choice to one or two materials.

The engineer usually has little choice in the type of spring used. The function of the spring and space limitations usually decide that for him. The engineer usually chooses the type of spring ends by balancing the manufacturing difficulty and costs with the application requirements. From the load-deflection characteristics required, the material size (dia-



Typical spring ends for compression and extension springs. These ends are standard and can be made conveniently.

meter round wire or thickness flat stock) is specified as well as the number of turns or the strip shape and length.

Balancing manufacturing economies against performance requirements in setting tolerances is one of the most important jobs of an engineer. Although the limits specified should not be closer than required, the engineer should appreciate the extremely small tolerances that can be held if necessary. Practically all of the spring charts and tables published to date to simplify spring designing incorporate commercial (comparatively wide) tolerances. In most cases, these tolerances are not applicable to precision springs because of exacting physical and loading specifications. Quite often a precision spring manufacturer is required to calibrate springs within 1% on the spring rate and maintain hysteresis errors below 0.02% of the spring's deflection, including temporary variation.

Compression and Extension Springs

The accompanying illustrations show typical ends for compression and extension springs. These ends are standard and can be made conveniently.

In the equations for round, helical compression and extension springs (see Table 1), the total number of turns is not the number of active turns. The total turns vary with the type of end used in the spring; the engineer usually specifies only the number of active turns.

Some initial tension can be put into extension springs. The maximum tension that can be put in depends primarily on the spring index—the lower the index the greater the initial tension. It is advisable to keep the index above 3, however. With values below 3, springs become expensive and difficult to make.

Space is often a limiting factor in designing a spring, and its length and diameter must be calculated carefully for all conditions. The method of finding H_0 the length of the coil, is shown in Table 2 for various ends. Calculating H_1, the hook length is more difficult. See equation (3).

Frequently, springs fit into holes or over rods, and their outside diameter or inside diameter is limited. Under these conditions, buckling must be considered. (See graph). The natural increase in the diameter of the spring as it is compressed is also a problem. The formula used to calculate the increase in the mean diameter of a wound wire spring is equation (4).

One of the most important factors in calculating spring stresses is consideration of the Wahl stress direction coefficient. This factor must be considered if fatigue loading or high stresses are involved. Without fatigue loading the Wahl factor can be neglected or used as a factor of safety. Most spring charts heretofore published do not include this factor. It is calculated by use of equation (5).

Table I—Spring Equations and Definitions

Compression and Extension Springs

(1) $N_a = \dfrac{FGd}{8PC^3}$

(2) $S = \dfrac{PCK}{0.4\,d^2}$

(3) $H_1 = N_a\,d + N_a\,(OBC) + S_e$

(4) $D_I = \tfrac{1}{2}\sqrt{P^2 + 4D^2 - d^2}$

(5) $K = \dfrac{4C - 1}{4C - 4} + \dfrac{0.615}{C}$

(6) $N_t = 4\Gamma Fa\,10^6 \times \dfrac{(C_2 - C_1)}{(C_2^4 - C_1^4)}$

(7) $S\,\max = \dfrac{PC_2K}{2\alpha ab}$

(8) $N_t = \dfrac{FGd}{2P} \times \dfrac{C_2 - C_1}{C_2^4 - C_1^4}$

(9) $S = \dfrac{PC_2K}{0.4\,d^2}$

Torsion Springs

(10) $B = \dfrac{10.2\,M}{d^3}$

(11) $\theta = \dfrac{1167LM}{d^4E}$ deg (deflection)

(12) $N = \dfrac{\text{Developed Length of Wire}}{\pi D}$

(13) $D_I = D_2\,\dfrac{N}{N - n}$

(14) $\theta = \dfrac{682LM}{ab^3E}$ deg (rotation)

(15) $B = \dfrac{6M}{ab^2}$ psi

(16) $B = \dfrac{6M}{ab^2}$ psi

(17) $\theta = \dfrac{682LM}{ab^3E}$ deg

Flat Springs

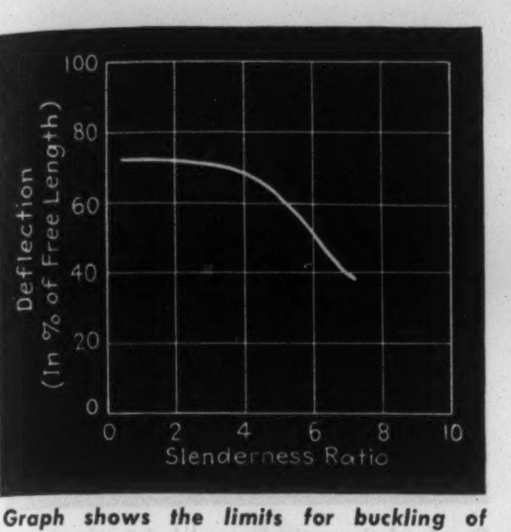
(18) $Y = \dfrac{PL^3}{3EI_0}$ in.

(19) $S = \dfrac{6PL}{ab^2}$ psi

(20) $Y = K_1\,\dfrac{PL^3}{3EI_0}$ (in.)

(21) $B = \dfrac{6PL}{ab^2}$ (deg)

a = width of material (in.)
B = bending stress (psi)
b = thickness of material (in.)
C = spring index, $\dfrac{D}{d}$
C_1 = small mean index, $\dfrac{D_1}{b}$
C_2 = large mean index, $\dfrac{D_2}{b}$
d = wire dia (in.)
D = mean dia of spring coil at full length (in.)
D_I = mean dia compressed (in.)
D_1 = small mean dia (in.)
D_2 = large mean dia (in.)
E = modulus of elasticity (psi)
F = deflection (in.)
G = torsional modulus of rigidity (psi)
H_0 = coil length (in.)
H_1 = free hook length (in.)
I_0 = moment of inertia (lb in.^{2})
K = Wahl factor, or stress coefficient factor
K_1 = ratio factor (see graph)
L = active length (in.)
M = deflection moment (lb in.)
N = number of turns in free position
N_a = number of active turns
N_t = total coils
OBC = opening between coils (in.)
p = pitch (in.)
P = load (lb)
S = stress (psi)
S_e = end factor
Y = deflection (in.)
Γ = shape correction coefficient for deflection
2α = shape correction coefficient for stress
θ = deflection (deg)



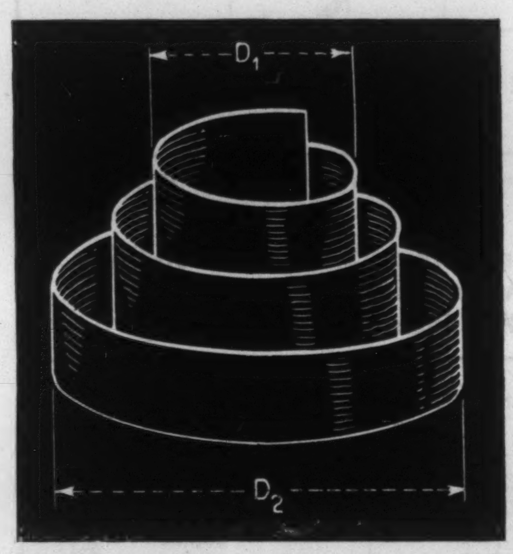
Graph shows the limits for buckling of helical compression springs with ends moving against each other only in the axial direction. Buckling will occur if spring deflection exceeds limit set by curve. (Courtesy SAE War Engineering Board "Manual on Design")

To determine the working stress allowable for any spring the engineer must consider the material used, the type of ends, the loading (static, repeated, eccentric), the wire size (Table 3) and the type of stress (torsion, bending). Table 4 illustrates the variation of minimum tensile strength with wire size for some spring materials. Table 5 lists the variation in maximum working stress in various materials.

In some applications the engineer must consider the natural vibrating frequency of the spring. Springs subject to rapid reciprocating motion, valve springs for example, build up vibratory stresses (surging stresses) which may cause fatigue failures if they are allowed to become large enough. Resonance between the natural frequency of the spring and the impressed cycle should be avoided. The natural spring frequency must be kept well above the impressed frequency and harmonics should be considered carefully.

While most compression springs are the same diameter throughout their length, other types are sometimes used for special purposes. Volute springs give a large displacement and have good lateral stability even when compressed into very short lengths. A volute spring is a truncated paraboloid and is usually wound from rectangular section wire. As the spring is loaded, the bottom coils become inactive as they come to rest on the supporting member. The rate of the spring will, therefore, not be constant during loading, but will increase with increasing deflection. If the spring material is tapered slightly, the deflection-vs-force rate may be held constant. Untapered volute spring stocks are valuable for damping and are used in shock absorbers. The equations are (6) and (7).

The conical spring is somewhat similar, except that round wire is used. Conical springs are sometimes tapered only slightly so that the coils do not slide inside each other. The equations for conical springs are (8) and (9). Both conical and volute springs are difficult to make and neither is commonly used.



The advantages of volute springs include superior damping characteristics and increasing stiffness under higher loads. The stress distribution, which gives lower fatigue strength, is a disadvantage.

Torsion Springs

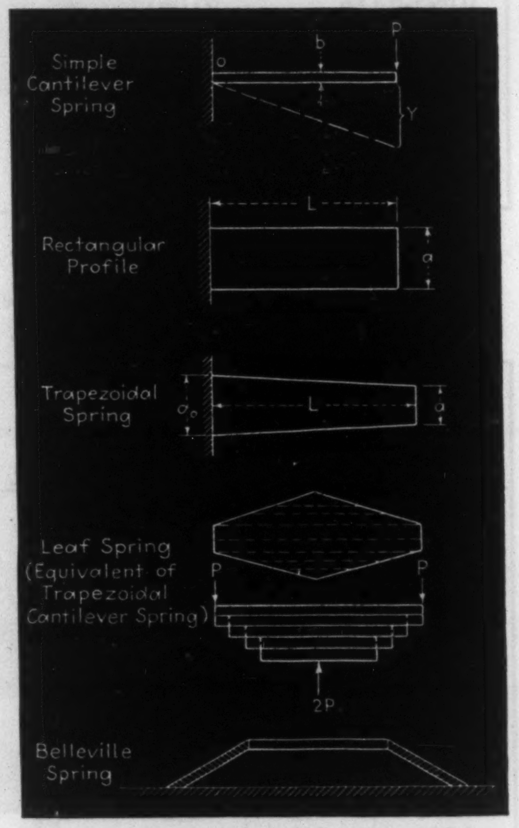
Torsion springs transmit a twisting action instead of a direct push or pull. They are made in innumerable variations: some hold objects in position with a steady torque; others wind up to store energy, which becomes available as they are permitted to unwind; others act as shock absorbers. Hinge springs and motor brush holder springs are typical torsion springs. The basic formulas used in designing a torsion spring are (10), (11) and (12).

The round wire, cylindrical torsion spring has different ends than extension and compression springs. The wire in the torsion spring is subject to bending stress. Extension and compression springs, on the other hand, subject the wire to torsional stresses. There is some stress concentration at the clamped ends of a torsion spring, depending on the severity of the bends, and this stress concentration can only be neglected when the spring is not subject to fatigue or frequent loading.

The engineer must also consider the way the springs are loaded. Torsion springs should wind up under load, reducing their diameter, since the springs are originally made by cold winding which sets up residual stresses. The maximum stress is lowered if the load is applied in the same direction as the original winding. The maximum stress is increased by loading in the opposite direction.

Diameter change with deflection is another factor in the choice of a torsion spring. If the full length of the spring is too long, it may buckle. This can be avoided by using initial tension in the spring, by providing guides, or by clamping the ends. If the spring diameter decreases too much, the spring may bind on a central shaft. In applications of this kind, equation (13) is used.

One variation of the torsion spring is the spiral type. The spiral spring consists of a flat strip of metal wound in a spiral. It has advantages in applications in which a limited space is available for a given energy storage. These torsion springs are used mainly in delicate instruments, and a high degree of accuracy is often required. The basic formulas with spiral springs are: (14) and (15).



Types of flat springs.

Torsion springs are usually made of round wire. When maximum energy storage is required, however, and the material must be used most efficiently, rectangular wire is employed. More material is subjected to the maximum stress in rectangular wire, and for a given spring index

Table 2—Coil Lengths for Various Spring Ends

Type of End	H_o (Solid Height)	N_t (Total Coils)	P_o (Pitch)	FL (Free Length)
Plain	$d(N_t+1)$	N_a	$\frac{FL-d}{N_a}$	$(P_oN_a)+d$
Ground	dN_t	N_a	$\frac{FL}{N_a}$	P_oN_a
Squared	$d(N_t+1)$	N_a+2	$\frac{FL-3d}{N_a}$	$(P_oN_a)+3d$
Ground and Squared	dN_t	N_a+2	$\frac{FL-2d}{N_a}$	$(P_oN_a)+2d$

N_t=*total coils;* N_a=*active coils;* d=*wire diameter;* FL=*free length of spring;* P_o=*pitch of spring coils.*

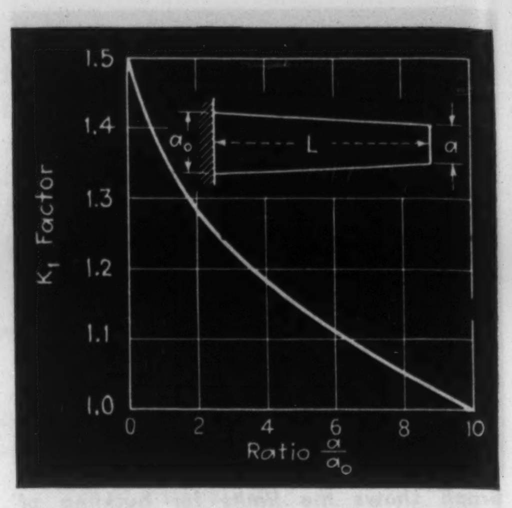
Table 3—Recommended Maximum Torsion Stresses for Helical Compression Springs under Average Service Conditions. Curvature Correction Included.

Wire Diameter, In.	Music Wire, Psi	Tempered Steel, Psi	Hard Drawn Steel, Psi
0.020-0.030	100,000	100,000	90,000
0.031-0.092	90,000	100,000	80,000
0.093-0.176	90,000	90,000	80,000
0.177-0.282	......	90,000	70,000
0.283-0.436	......	85,000	Cold wound for O.D. 3 in.
0.437-0.624	......	80,000–90,000	Hot wound for O.D. 3 in.
0.625-0.874	......	90,000	
0.875-1.249	......	80,000	Hot wound
1.25 -1.5	......	80,000	

Table 4—Minimum Tensile Strength of Spring Materials in Thousands of Pounds per Sq. In.

Size	Music Wire	Hard Drawn MB	Oil Temp. MB	Stainless 18:8	Temp. Alloy	Phosphor Bronze	Spring Brass
0.004	439	...	...	...	...	...	...
0.008	399	...	...	...	...	140	125
0.012	377	...	...	316	...	...	...
0.020	350	...	288	300	...	...	...
0.028	333	...	281	284	...	...	...
0.032	327	265	275	278	281	...	...
0.035	322	261	268	274	276	...	...
0.041	314	255	261	270	270	135	120
0.047	307	248	254	262	263	...	...
0.054	301	243	248	258	257	...	...
0.063	293	237	242	251	251	130	115
0.072	287	232	236	245	245	...	...
0.080	282	227	230	240	240	...	...
0.092	275	220	225	233	235	...	...
0.105	269	216	220	227	229	125	110
0.120	263	210	215	221	222	...	...
0.135	258	206	210	213	219	...	...
0.148	253	203	205	207	215	...	...
0.162	...	200	200	200	212	...	...
0.177	...	195	195	195	210	...	...
0.192	...	192	190	189	206	...	...
0.207	...	190	185	185	204	...	...
0.225	...	186	183	180	200	120	100
0.250	...	182	180	174	196	...	...
0.312	...	174	178	160	189	110	90
0.375	...	167	175	...	187	...	...
0.437	...	165	170	...	186	...	...
0.500	...	156	165	...	185	100	85

From "Standards for Mechanical Springs," SMA



Graph of the ratio factor used in the formula for cantilever spring of trapezoidal profile.

more material can be put into a spring with a given O.D. The design formulas for a rectangular wire torsion spring are (16) and (17).

Flat Springs

The simplest flat spring is the cantilever type. Almost all cantilever type springs are made of flat material. These may take a wide variety of forms and may perform other functions in a mechanism besides that of a spring. They are frequently used in electrical switches because they maintain constant pressure for long periods without interruption. The basic formulas for a constant section, rectangular cross-section cantilever spring having small deflections are (18) and (19).

The maximum stress in a cantilever spring occurs at the clamp. The clamp itself may increase the stress even further and the spring surface should be smooth and its edges rounded at the clamp, especially under fatigue loading. Holes and cut-

Table 5—The Maximum Working Stress in Various Materials

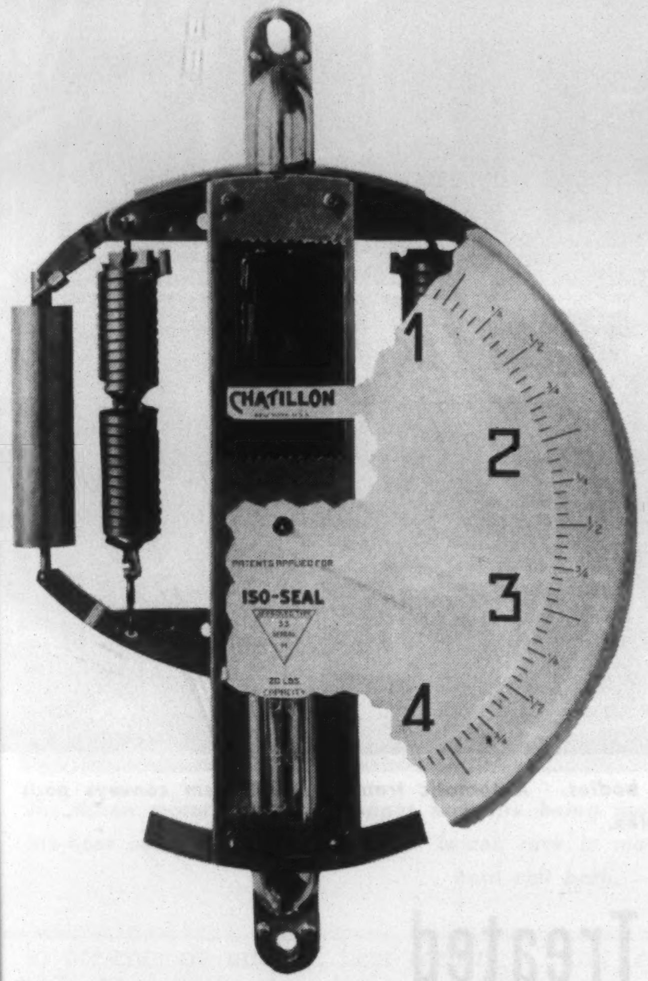
Material	Max. Working Stress (Bending), Psi	Max. Working Stress (Torsion), Psi
Iso-Elastic	90-100,000	40- 60,000
Beryllium-Copper	100-150,000	65- 95,000
Phosphor-Bronze	60-110,000	50- 85,000
Spring Brass	40- 60,000	30- 60,000
Inconel-X	110-135,000	55- 80,000
Inconel	110-135,000	55- 80,000
Stainless Steel	60-260,000	45-140,000
Hard Drawn	100-200,000	75-130,000
Oil Tempered	120-250,000	80-130,000
Music Wire	150-350,000	90-180,000
Chrome-Vanadium	180-230,000	100-130,000
Ni-Span-C	15-110,000	....
Elgiloy	230,000	....

outs at this section should also be avoided, of course.

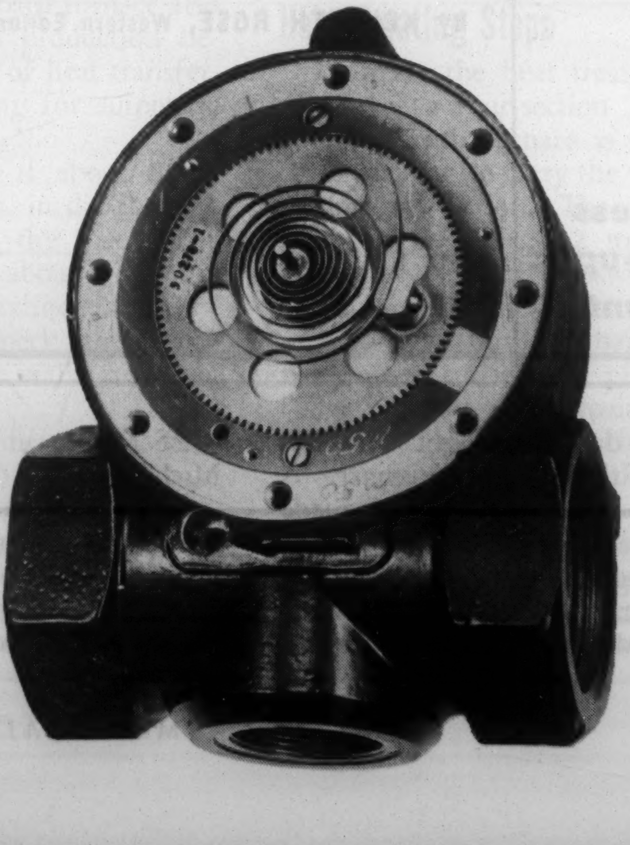
Cantilever springs are often made with trapezoidal profiles. This makes more efficient use of the material than a constant section spring. The leaf spring is an example of this type. The formulas for a trapezoidal spring are (20) and (21).

Simple flat springs can often be made of pre-tempered steel instead of annealed steel. Pre-tempered steel springs do not have to be heat treated after forming. They are only low-temperature stress relieved. Sharp bends must be avoided in this material, however, since failure undoubtedly will occur if radii are too abrupt. The size and shape of the blank also place some limitations on the thicknesses of pre-tempered steel that can be used.

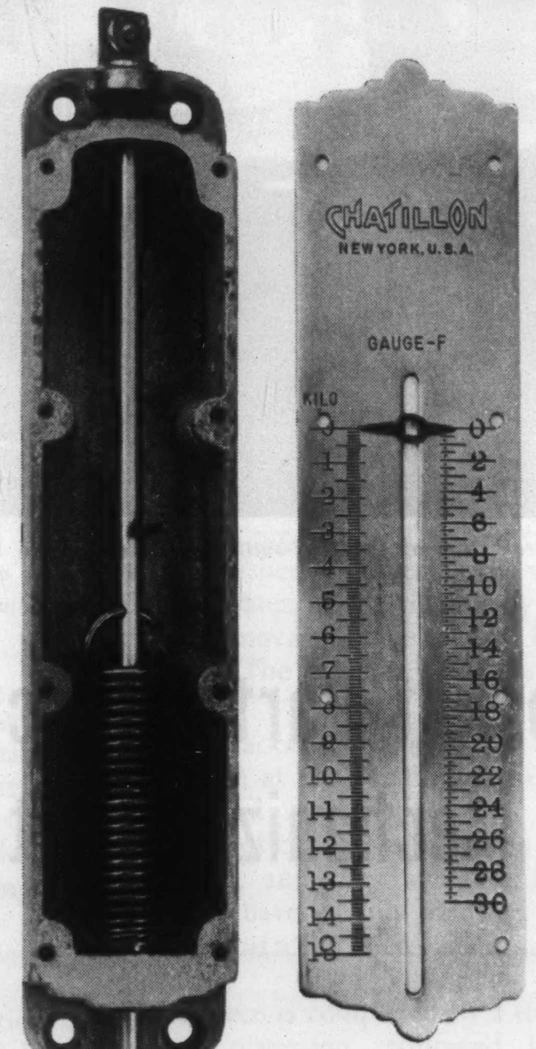
When the space is limited in the direction of load travel, either a Belleville spring or a radially tapered disk spring can be used. The mathematical analysis for both these springs is highly involved, and most design is done by charts, graphs or nomographs. The main difference between the two types is that the thickness of a radially tapered disk spring is proportional to the distance from the center, and the stress under load is roughly constant throughout the spring. Thus, more energy can be stored in a spring of this type than in a Belleville spring containing an equal amount of metal.



This scale is temperature-compensated by twin Iso Elastic springs accurate to 0.1%. Twin springs balance out some deflection errors.



A temperature-compensated Iso Elastic spiral spring is used in this Bendix fuel flowmeter. Accuracy is within 1%.



Push-pull gage illustrates the use of an extension spring with an inserted machine screw type calibrator. The accuracy of the calibrator is within 1%.

General view of the four-section furnace used to heat treat 3.5-in. rocket motor bodies. Automatic transfer mechanism conveys parts through four separate salt baths.

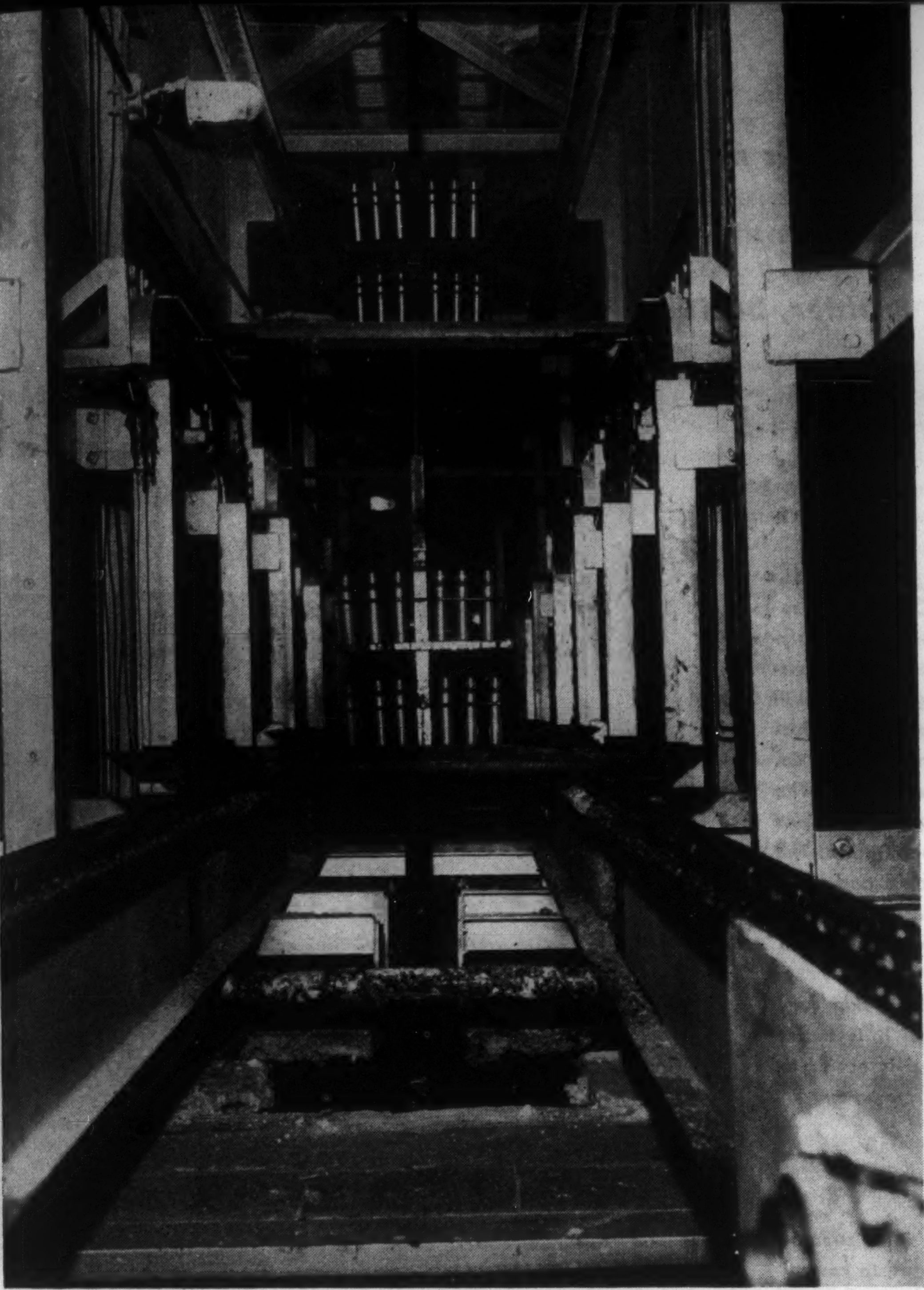
Rocket Parts Effectively Heat Treated in Mechanized Salt Bath Furnace

by **KENNETH ROSE,** Western Editor, Materials & Methods

Accurate control of hardness maintained in high production set-up in Oldsmobile's rocket plant.

● ONE OF THE MOST dramatic of America's smaller weapons is the 3.5-in. rocket, small enough to be handled by one or two men, powerful enough to destroy a tank. The rocket itself includes a propelling unit and a bursting charge, with fins to guide the missile during its flight. The container for the propelling charge is termed the motor body, and is made of alloy steel heat treated to give it best strength with the necessary shock resistance. Oldsmobile Div. of General Motors is manufacturing these rockets in a plant at Lansing, Mich.

Heat treating the rocket parts requires accurate control of hardness, nonscaling, and quantity production. The motor body itself is tubular in form, necked down at one end, and



The dozen motor bodies on upper rack are being moved from charge end of furnace to pre-heat salt bath in foreground. Lower rack is moving from pre-heat section to high heat salt bath.

so presents no unusual heat treating difficulties from the standpoint of irregular sections or handling in the furnace. It was decided to do the heat treating in a salt bath furnace to obtain protection for the work during treatment, along with uniformity of heating. The salt bath furnace also lends itself to high production because of the rapidity of heat transfer, and ease of arranging for automatic operation.

The motor body is about 8 in. long, and about 2 in. in dia through the largest part of the piece. The cylindrical portion is about 6 in. long. At one end of the cylinder the tube cones down to a neck about 1¼ in. in dia. The tube walls are about ⅛ in. thick.

The material used is SAE 4140 steel, and comes to the heat treat operation in the annealed condition. The pieces are machined to finished dimensions before heat treating so all sizes must be held to close tolerances. Also, the hardness requirements permit little variation. Distortion is held to a minimum in the salt bath furnace by using a quenching salt bath held at a temperature just above martensite transformation zone so as to slow transformation rate through the range of volume change.

Heat Treating Steps

To make the heat treat operation automatic, a four-section Ajax-Hultgren salt bath furnace is used, with conveyorizing to carry the work from section to section. The pieces are mounted on racks, 12 to the rack. The racks extend crosswise in the furnace, with the ends carried by lugs on twin conveyor chains and the workpieces carried on pins on the conveyor racks. Conveyorizing of the furnace is so arranged that loading and emptying the racks takes place at the same position, so that only one man is needed for manual operations of feeding and emptying the conveyor. A second man checks furnace operation, the temperatures in each furnace section, and adds make-up salt when necessary.

After a rack has been loaded, it is carried upward by the chain conveyor, then to the opposite end of the furnace, and there is lowered into the first section of the furnace to preheat the steel. A neutral salt is used in this section.

The work is moved from the preheat bath by the chain conveyor and quickly lowered into the high-heat section in which the work is brought up to quench temperature. Sufficient time is allowed for the work to come to full quenching temperature. The salt used is the same as that in the preheat bath.

Quenching is performed using the chain conveyor in the same way as the other transfers from section to section of the furnace. The rocket bodies are quenched into a molten salt bath held just above the martensite transformation temperature. This high temperature reduces the danger of distortion to a minimum. The work remains in the quench for sufficient time to allow the entire section to reach the temperature of the bath.

After quenching, the work must be tempered to meet yield strength and ductility requirements. This section of the furnace, therefore, contains a high-temperature tempering salt at a temperature which will give the required end properties. The heat treatment is finished by lowering the work into hot water to cool it quickly and permit removal of the pieces from the racks. The water is held at about 190 F.

As the racks move out of the water they arrive at the loading-unloading station, and are emptied. The heat treatment of the rocket pieces is now completed, and they are free from scale but have a thin oxidized film over all surfaces. There is no adhering salt.

The piece is completed by a thread chasing operation, followed by a bonderizing treatment. Before bonderizing, the work is subjected to a hydrostatic test in which it is required to hold oil under 25,000 psi.

Furnace temperatures are automatically controlled at each section. In addition to constant checking of temperatures during operation of the furnace, laboratory controls of the salts in each bath are run to determine when the composition changes sufficiently to require replenishing. Make-up salt is added three or four times a day, and about once a week the furnace sections are cleaned to remove accumulated sludge.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .

LAMINATED PLYWOOD TRUCK TRAILER

A new refrigerator truck trailer made of cellular plastic-laminated plywood and called the Unicel has been introduced to the transportation industry. The new vehicle was designed and built by the Pressed Steel Car Co., Inc., of Chicago to specifications furnished by the Brown Equipment & Manufacturing Co.

Unicel's plastic-faced plywood saves scarce metals. The only steel used in its construction is in the heavy duty tandens and kingpin wearplate assembly and in the floor frames. The new trailer is more rigid than all-metal models and pulls easier and maneuvers more handily. Although it is lighter than conventional trailers, it has more room for cargo, with the same standard clearances.

The body cannot rust or corrode, and the stress-skin construction absorbs road shocks and stains better. It is better insulated, weather resistant, moisture-proof, and is easier to clean than metal trailers, and according to the manufacturer, is easier and faster to make.

STAINLESS STEEL VALVE PART

This 3-in. streamflow-type plunger and cage is part of a valve used to control flows of fluids under pressure. Primary adaptation is in pump governors and steam pressure reducing valves, controlling flow of steam under high velocities. It can also be used as part of a regulator controlling flow of feed water into a boiler drum. The design assures accurate response to actuating forces by minimizing the unbalance always present when fluids are handled under high-pressure conditions.

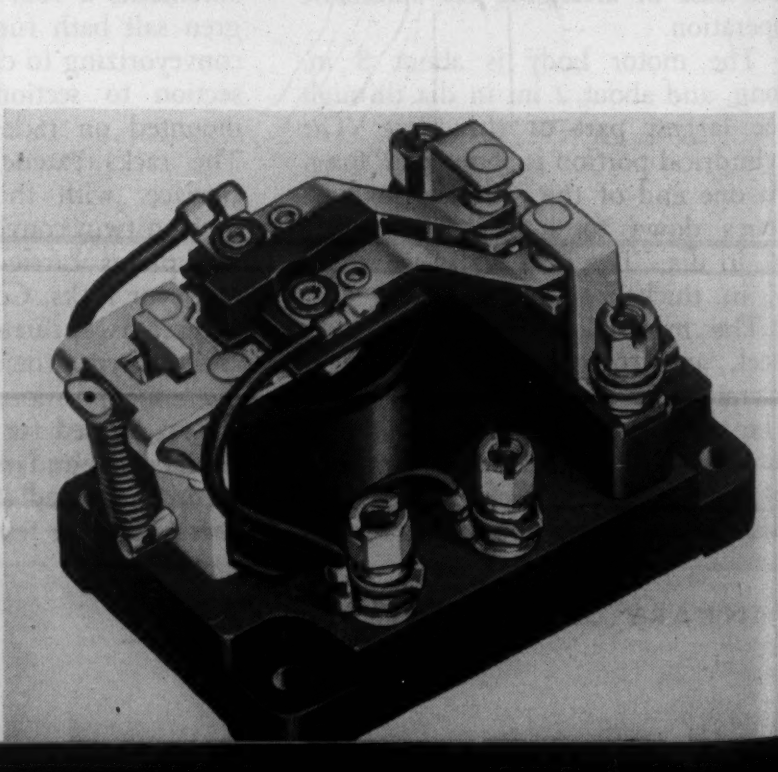
The manufacturer was producing the part from a stainless casting. Wear resistance, corrosion resistance and high pressure resistance were necessary. The machining tolerances were also close, and finish was important. The material specification was changed to Carpenter Steel Co. stainless No. 5 (Type 416) bar stock. In addition to meeting all of the basic requirements, the new steel, heat treated in customer's plant to 300 Brinell, cut scrap losses 25%, reduced material costs 50%, and enabled them to increase production 10%.

THE CARPENTER STEEL CO.
STAINLESS STEEL

PHENOLIC RELAY BASE

The Ward Leonard Electric Co. has developed a new multi-pole Midget Magnetic Relay. It is designed for general- and special-purpose uses such as traffic signals, machine tools, alarms and heaters. This type of relay is particularly suited to applications that involve vibration. The overall construction is compact and sturdy. Metal parts are attached securely to a base of Durez phenolic.

Through and blind holes and inserts are all molded in this base, so that there is little fabrication work, finishing is inexpensive and assembly is easy and quck. Corroson resistant parts make for a long and reliable life for the relay. Heavy-duty, silver-to-silver contacts are self-cleaning and self-aligning.

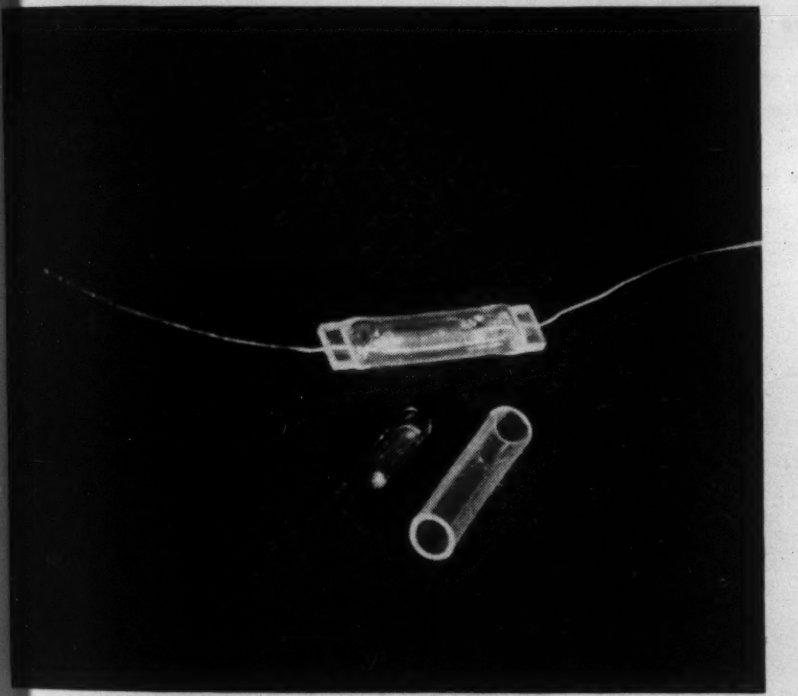


ALUMINUM BULB BASES

General Electric's Lamp Dept. is now using aluminum instead of brass for a large portion of its output of bases for incandescent electric light bulbs. The company is now in a position to use either brass or aluminum, depending on the supply situation. This new use of aluminum has been approved by the National Production Authority.

The successful use of aluminum required an alloy which would withstand the high temperatures used by machines on which lamps are assembled. It also required a solder and a flux suitable for a high-speed automatic soldering of the filament wire to the shell. In addition, it was necessary to make exhaustive tests concerning such matters as electrolytic corrosion in brass and copper sockets, corrosion characteristics in various atmospheres, and contact resistance between the base and socket.

In addition to maintaining a better appearance than brass bases, the aluminum boasts such advantages as having excellent electrical properties, being 2½ times as good a conductor of electricity, and having greater resistance to acids and a variety of atmospheres. G-E manufacturing people see aluminum as being the standard metal for the bases of most of its lamps whenever the metal supply situation returns to normal. Until that time arrives, both brass and aluminum probably will be used.



NYLON TUBING FOR THERMISTORS

Extruded nylon tubing is now being used with thermistors. Tubing about the diameter of an ordinary lead pencil is used to encase one type of glass enclosed bead thermistor used in time-delay circuits. The thermistor is inserted in a length of tubing and the ends of the tubing are pressed flat under heat in a hydraulic press for a given length of time to give the nylon the set desired. Connecting leads extend outside the nylon casing.

The tubing provides mechanical protection of the glass bulb, electrical insulation (no metal end caps are required) and protects against straining the glass bulb through flexure of the connecting leads. Nylon readily takes the shape desired and is heat resistant. Assembly is rapid and simple, and cost reductions have been achieved by using the nylon tubing instead of a phenolic cartridge with metal end caps.

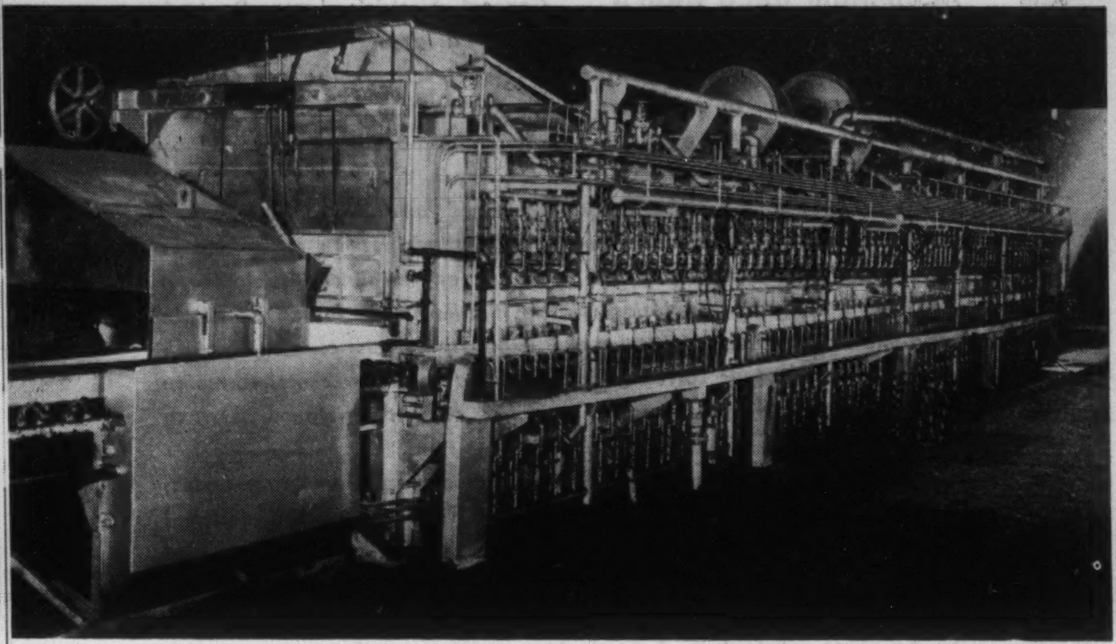
Heat resistance is important because the connecting leads are soldered during assembly into circuits and the apparatus in which the thermistors are used must operate properly over a wide range of temperatures. The tubing itself is manufactured by Anchor Plastics Co., New York City.

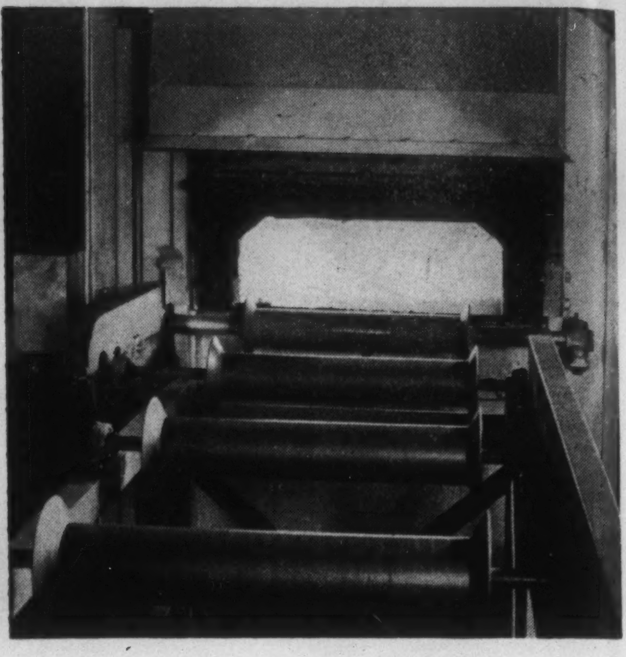
MW WROTSTL WLS
D&H
16153

ALLOY STEEL FLAT CAR

This flat car, designed to carry 500,000 lb., was assembled by the Delaware & Hudson Railroad. The one-piece and span bolsters were cast in low carbon 2% nickel steel. The floor, U. S. Steel Cor-Ten, high strength, low alloy steel, is ½-in. plate attached to the top surface of the frame casting by a continuous weld. Slots for T-head bolts and 1¼-in. holes are provided to secure loads. The total frame length over striking plates is 45 ft., 4 in. The car is 10 ft. wide in the center, and 4 ft. ½ in. high from the top of the rail. The General Steel Castings Corp. made the underframe and floor plates; Buckeye Steel Castings Co. produced the span bolsters and truck bolsters. The car weight is 97,000 lb.

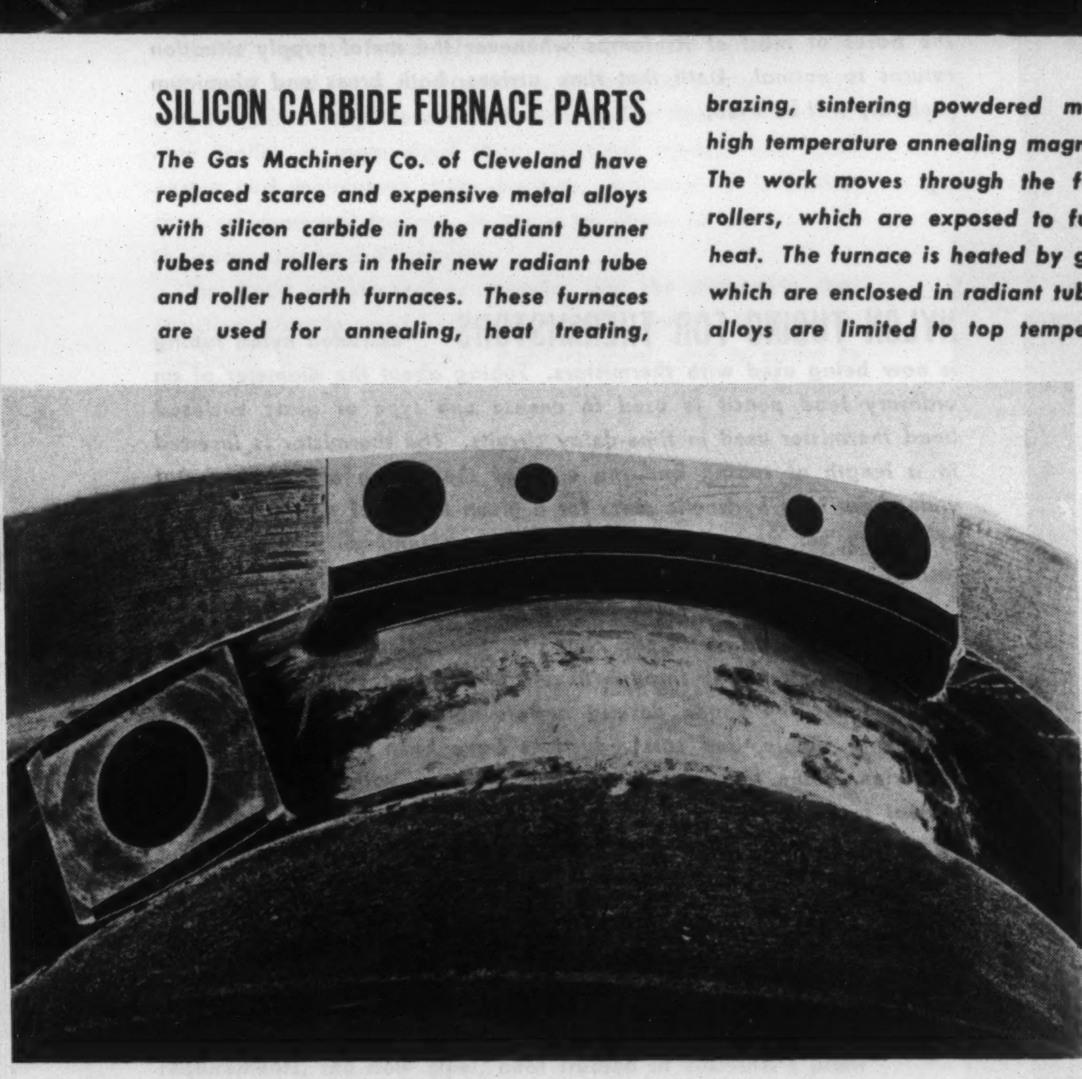
Materials at Work

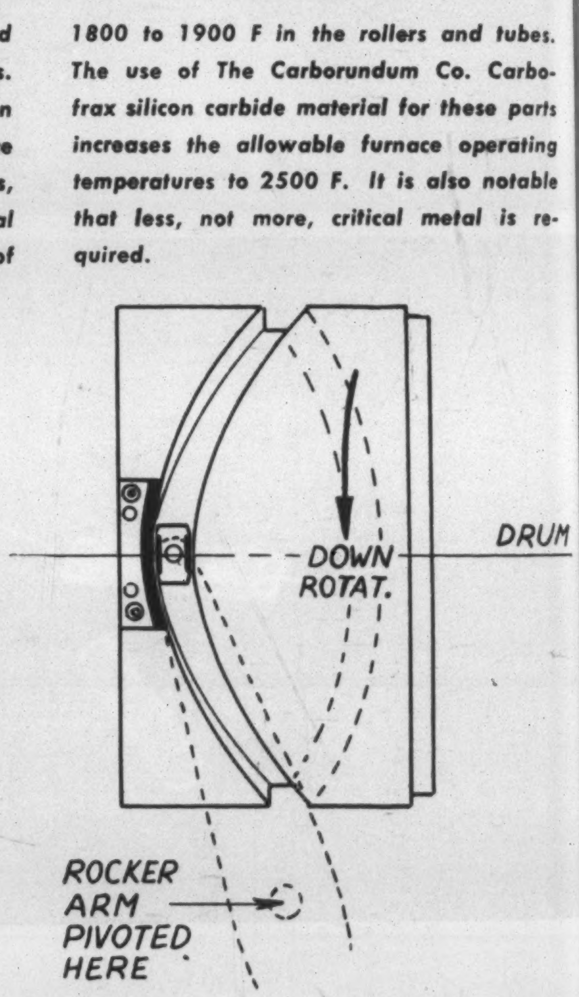




SILICON CARBIDE FURNACE PARTS

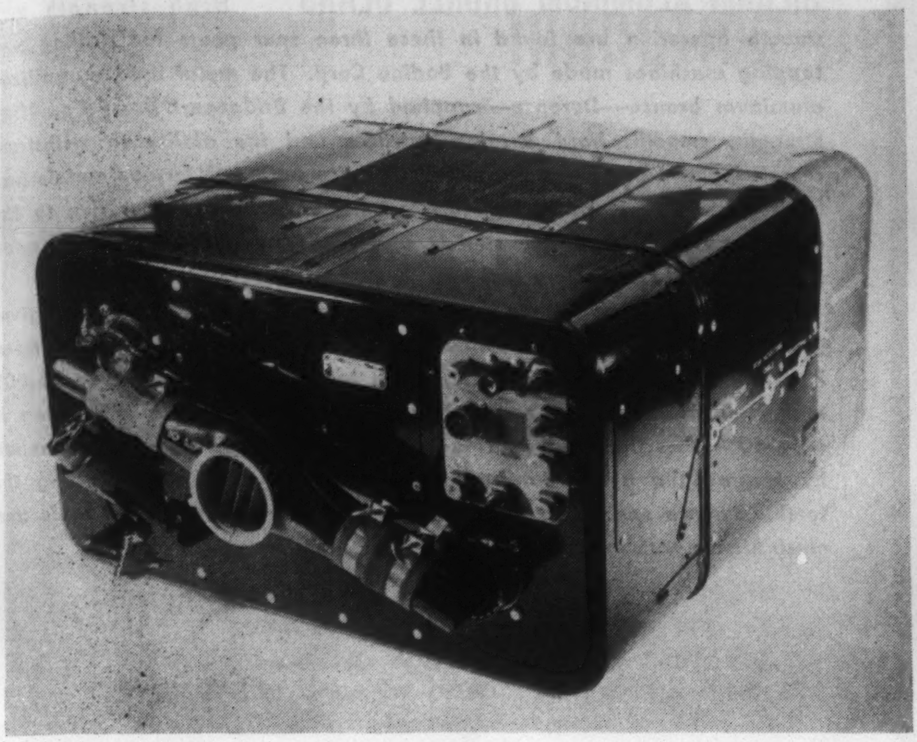
The Gas Machinery Co. of Cleveland have replaced scarce and expensive metal alloys with silicon carbide in the radiant burner tubes and rollers in their new radiant tube and roller hearth furnaces. These furnaces are used for annealing, heat treating, brazing, sintering powdered metals and high temperature annealing magnet metals. The work moves through the furnace on rollers, which are exposed to full furnace heat. The furnace is heated by gas flames, which are enclosed in radiant tubes. Metal alloys are limited to top temperatures of 1800 to 1900 F in the rollers and tubes. The use of The Carborundum Co. Carbofrax silicon carbide material for these parts increases the allowable furnace operating temperatures to 2500 F. It is also notable that less, not more, critical metal is required.

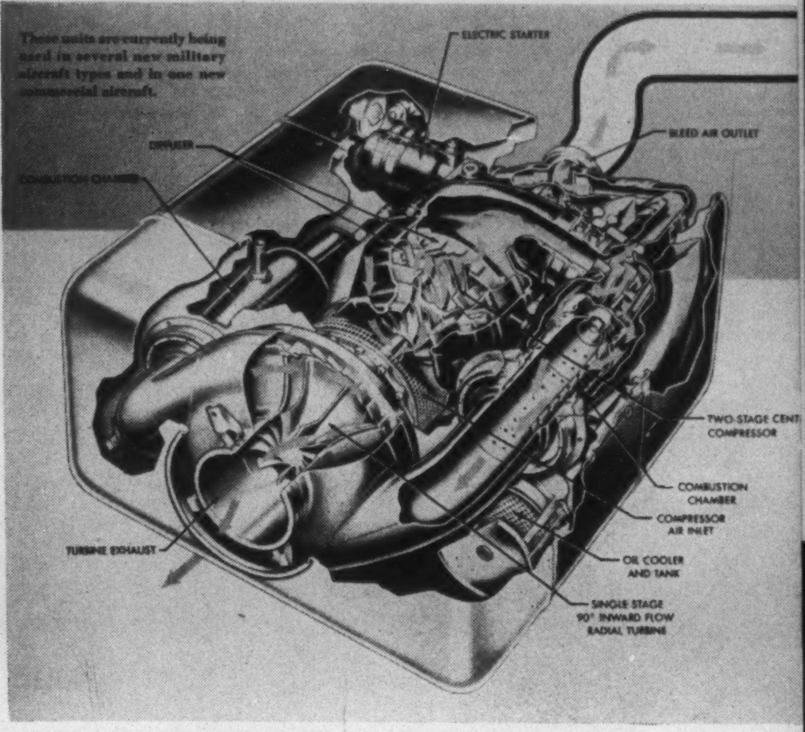




CEMENTED CARBIDE ROTARY CAM AND SHOE

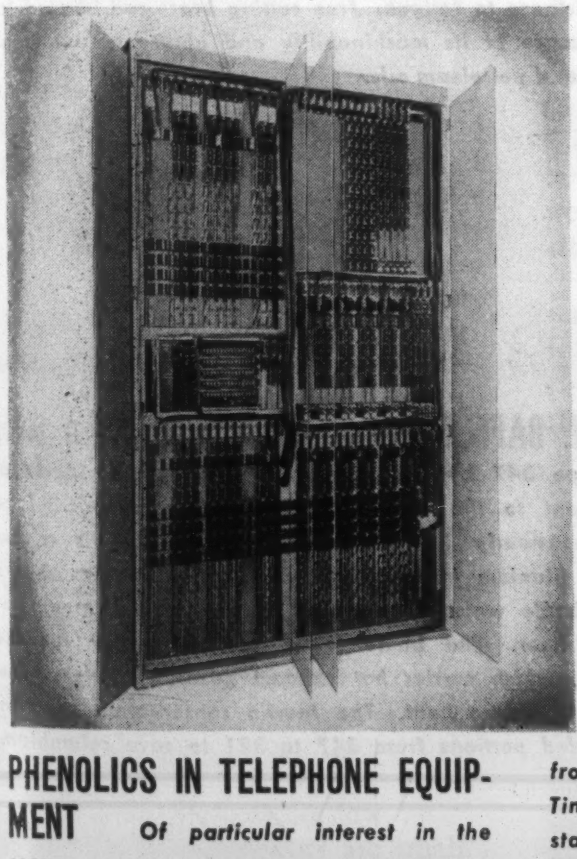
By fabricating an insert for a cam track from a standard Carboloy cemented carbide strip and by adding blanks of Carboloy cemented carbide to the two bearing sides of the cam shoe, the Fort Wayne Works of the General Electric Co. has eliminated the rapid wear and play between shoe and track which had resulted in costly machine downtime and cam replacement. The use of carbide has also given an improved machine operation. In the circumferential cam track, excessive wear occurred only at the point where the cam shoe made an abrupt turn—about 300 times a minute in this particular machine type. As soon as the fit became slightly loose, impact would seriously accelerate further wear. Metallizing, hard alloy inserts and other methods of reclamation had been tried but found relatively ineffective. Machine action was not only extremely noisy, but the percentage of reject work due to excessive clearance and play increased rapidly. With the number of these semi-automatics in use at the plant, an average annual replacement of 30 drums was involved. The solution used was to braze a 4-in. strip of cemented carbide to a larger machine steel block and attach this to the cam track drum by means of studs to form the part of the track subject to excessive wear. Wear on the cam shoes occurred primarily along the bearing sides, the pin hole wear being practically nil. To add the carbide blanks, the inserts were slotted at one end for loose fit of a $^1/_8$-in. dowel pin extending through the shoe. The cam track itself serves to lock the inserts in place, eliminating necessity for brazing. A radius was ground on one side of the blank to provide a bearing surface. This grinding also serves to size the blank to the best possible fit in a worn cam track. From experience to date, indications are that both shoes and track now can be expected to last the life of the machine. In the event of earlier failure, cost would be quite low in comparison to the former practice.

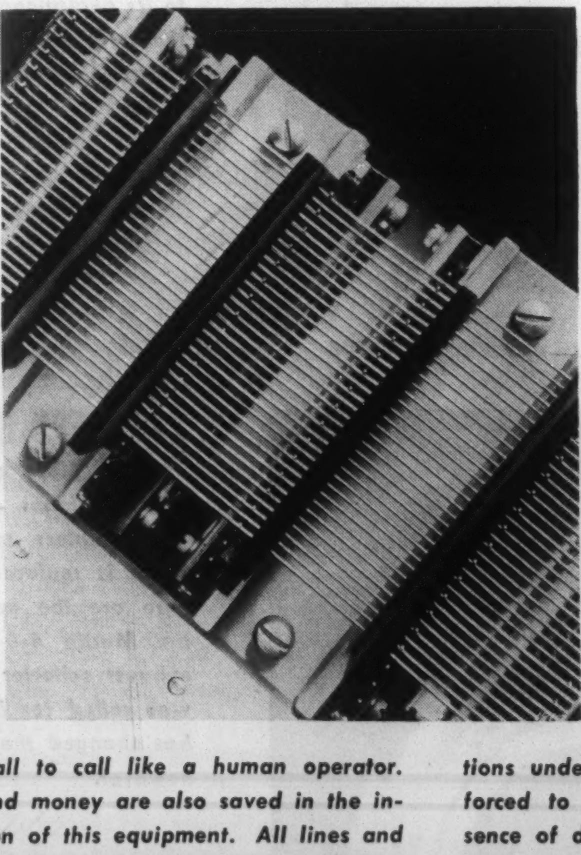


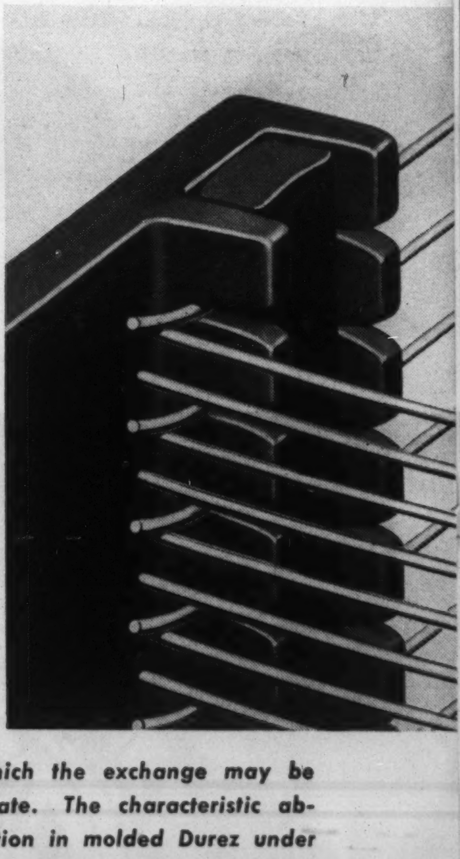

These units are currently being used in several new military aircraft types and in one new commercial aircraft.
ELECTRIC STARTER
BLEED AIR OUTLET
DIFFUSER
COMBUSTION CHAMBER
TWO-STAGE CENT
COMPRESSOR
COMBUSTION CHAMBER
COMPRESSOR AIR INLET
OIL COOLER AND TANK
SINGLE STAGE 90° INWARD FLOW RADIAL TURBINE
TURBINE EXHAUST

NICKEL ALLOYS IN GAS TURBINE

A new gas turbine—one of the smallest in the world—has been designed by the AiResearch Manufacturing Co. of Los Angeles. The new turbine is now being used as the power source in airplane pneumatic power system. It is about the size of a suitcase, weighs 150 lb and produces 65 air hp or 84 shaft hp. In such a high temperature machine, nickel alloys are, of course, used plentifully. The entire unit is enclosed in an 18:8 stainless envelope. To obtain maximum service life in the reduction gears, ASM 6250 (equivalent to 3310 type nickel-chromium steel) is specified. Speed reduction in the gas turbine shaft power unit is from 50,000 to 6000 rpm, and in the air turbine starters, from 84,000 to 3650. This nickel alloy steel meets the unusually severe requirements imposed by the heavy loads on the mating surfaces of the gear teeth. The most critical and dramatic use of nickel alloys in the unit is in the "hot wheel," or turbine rotor assembly, the most critical part of the turbine itself. The wheel operates at speeds of 40,000 rpm and at temperatures of 1600 F. Inconel, a high nickel-chromium iron alloy, was the only material tested by AiResearch which will not expand from molecular growth and cause seizure at this speed and temperature. Other metals, such as tungsten, chromium steel and cobalt steel, did not meet the exacting requirements. The hot wheel was rough forged by Steel Improvement and Forge Co., Cleveland, and finished at the AiResearch plant.

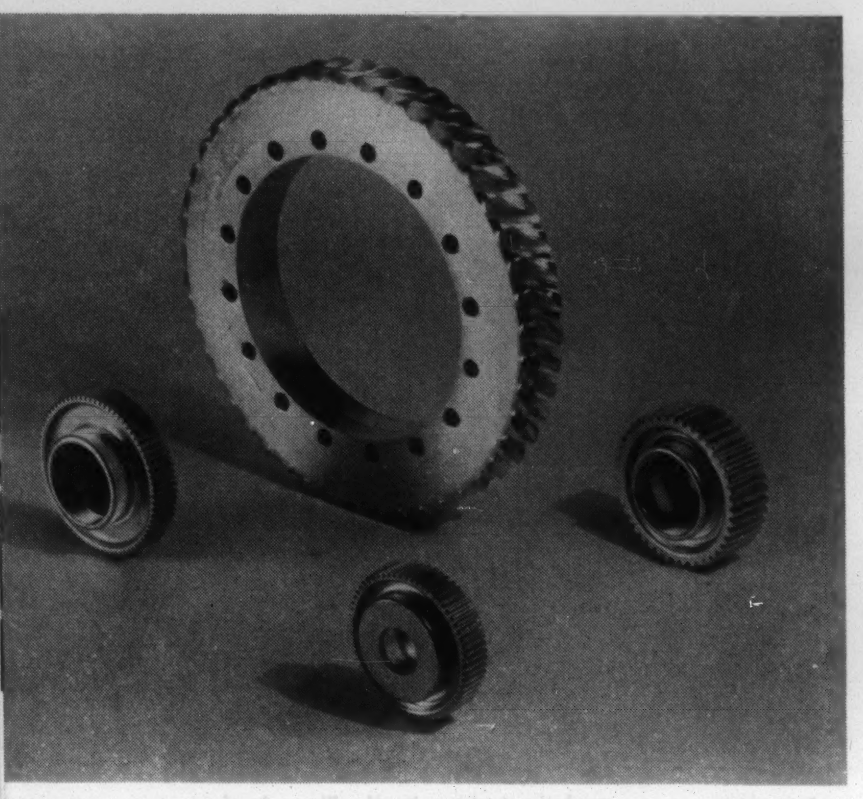






PHENOLICS IN TELEPHONE EQUIPMENT

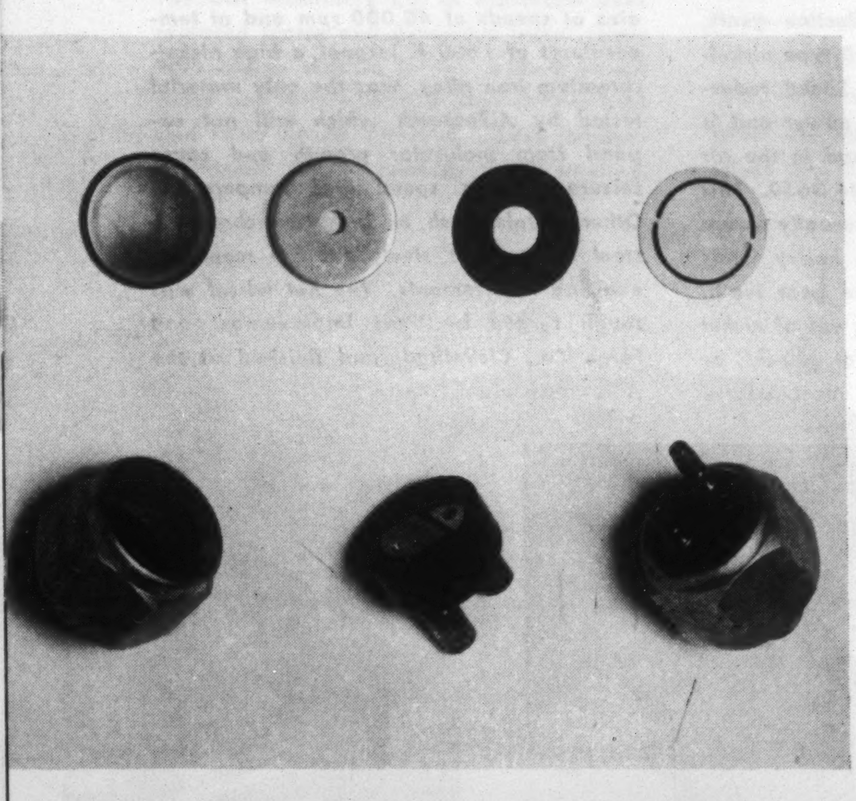
Of particular interest in the MCXR, a new switchboard assembly for automatic dial exchanges made by The North Electric Manufacturing Co., is the Common Control. In earlier exchanges 30% of the equipment was used for only 5 sec while the call was being connected. With MCXR, the Common Control proceeds from call to call like a human operator. Time and money are also saved in the installation of this equipment. All lines and links are jack mounted and line finders are interchangeable. Durez phenolic is used throughout the MCXR in the construction of relays, jacks and multiple guides. This self-insulating, thermosetting material, once molded, is not affected by extreme variations of temperature and moisture, conditions under which the exchange may be forced to operate. The characteristic absence of distortion in molded Durez under extreme pressure makes it ideally suited for use in the wedge-lock multiple assembly. Wires must be held firmly and lastingly in place under a live pressure of 100 tons per sq in. Molding for North Electric is done by The General Industries Co.



SILICON ALUMINUM BRONZE GEARS

High strength and smooth operation are found in these three spur gears for drilling and tapping machines made by the Bodine Corp. The metal used was silicon aluminum bronze—Duronze—supplied by the Bridgeport Brass Co. High strength, smooth, hard bearing surfaces and the ability to withstand corosion and wear were demanded in these parts. If ferrous metals had been selected, the machining costs would have been higher due to the comparatively low surface speeds and feeds necessary to obtain good tool finish and satisfactory tool life.

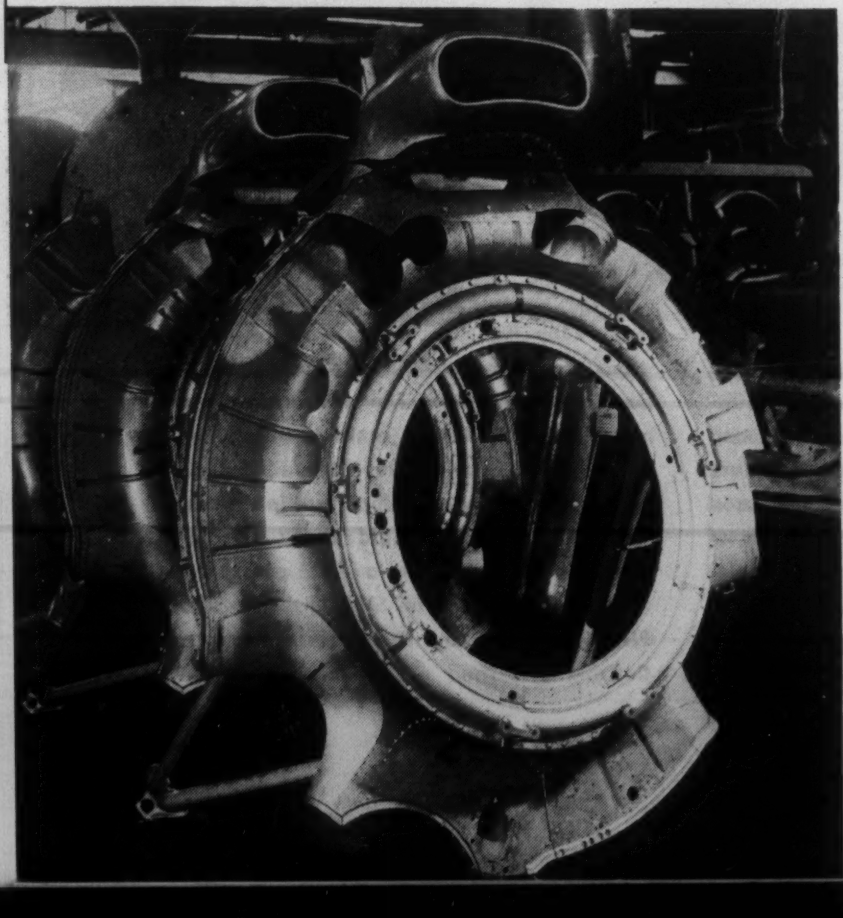
Silicon aluminum bronze meets the design specifications and gives good machining qualities besides. This alloy contains about 91 copper, 7 aluminum and 2% silicon. It has a tensile strength between 85,000 and 90,000 psi in the annealed condition. Its machinability rating is only 40% less than that of free-machining brass. The gears were made by forging the blank, turning, drilling, boring, taping and cutting the teeth. Surface speeds up to 150 to 250 fpm with high-speed tools and much higher with tungsten carbide tips are possible.



COPPER ALLOYS IN STOP LIGHT SWITCH

This stop light switch for automobile hydraulic brake systems was designed by Fasco Industries Inc., Rochester, N. Y. Phosphor bronze and free turning brass were used selectively for both mechanical and electrical applications to ensure long service. Brake pressure forces oil against a composition rubber diaphragm, applying pressure to a phosphor bronze diaphragm, which, in turn, closes a phosphor bronze switch leaf to make the electrical contact. When the brake is released, the bronze diaphragm acts as a cricket, snapping back to open the switch against the residual hydraulic pressure of the system.

Because of the countless making and breaking operations of the switch in the normal car life, spring temper phosphor bronze was selected due to its exceptional resistance to fatigue. Free cutting brass rod is used for the terminal pins because of its machinability and ability to withstand corrosion by moisture and petroleum oils.



STAINLESS STEEL BAFFLE

Type 321 stainless steel is being used in place of Type 347 by The Glenn L. Martin Co. in parts of their airplanes adjacent to the engines and exposed to heat. Type 347 stainless contains nearly 1% of scarce columbium. This critical metal is replaced by titanium in type 321. The sub-assemblies shown here are the outer baffle which is attached to the engine mount of the Martin 4-0-4 airliner. The baffle forms a passageway for the exhaust collector ring, which carries hot exhaust gases. Stainless steel was called for because of the heat. The Martin conservation program has changed the welded portions from 347 to 321 to save columbium, however.

Induction Descaling Proves a Fast, Economical Method for Cleaning Steel

by **HOMER KINCAID**, Assistant Works Metallurgist, Farmall Works, International Harvester Co.

• THE DESCALING OF hot-worked steel before machining pays returns in longer tool life, and in some cases in more accurate machining. Descaling is conventionally done by blast cleaning or by chemical cleaning. Blast cleaning is slow, and labor costs are high, but it provides the best means for removing certain types of scale, particularly sand scale on castings. Chemical cleaning with acids, usually called pickling, is fast, and labor costs are low, but the procedure is usually messy and disposal of the waste acid is becoming a major problem in most localities.

Descaling by means of heat has been tried, but has not been widely adopted. Now an induction heating method has been worked out by metallurgists of International Harvester Co. in cooperation with engineers of the Tocco Div., Ohio Crankshaft Co., which brings a new variation to descaling procedures. The theory of removing scale by induction heat is to raise the temperature of the surface scale rapidly enough to cause expansion to a degree where it will separate from the cooler base metal. This condition, together with the progressive heating of the surface scale and the irregular electrical characteristics, breaks it into small pieces as it separates from the base metal.

Some advantages of the process are—

1. It can be operated as a continuous method.
2. There is no acid disposal problem.
3. Operating costs are low.
4. Space requirements are small.

By passing the work through the induction unit continuously, high production and low costs can be achieved. The induction heating unit itself is quite compact, and is the only item that requires plant space except for the stock being descaled. The process is rapid and clean, and the work comes from the machine ready for processing after only brief cooling in air.

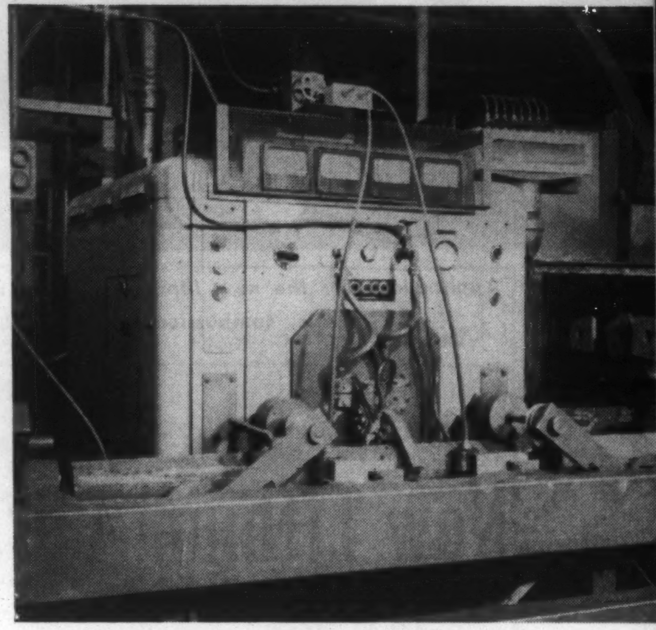
Some limitations of the method are—

1. It is adaptable to pieces of regular cross-section only. The work should be preferably of such shape that it can be passed through the induction heating coils continuously.
2. Initial investment is higher than for other methods.
3. Descaling may not be complete at 350 F, the temperature used. Where the scale is held in crevices in the work, it may not pop off completely during passage through the unit. The process is sufficiently effective to produce work clean enough for machining, however. A decrease in effectiveness was noted if axles were allowed to stand more than 8 hr after the draw and cooling.

Work upon induction descaling was begun at the Farmall Works of International Harvester Co. about four years ago, and after about a year's experimenting the method was dropped temporarily. It was reinstituted about a year ago, and has been used successfully on a production basis since that time.

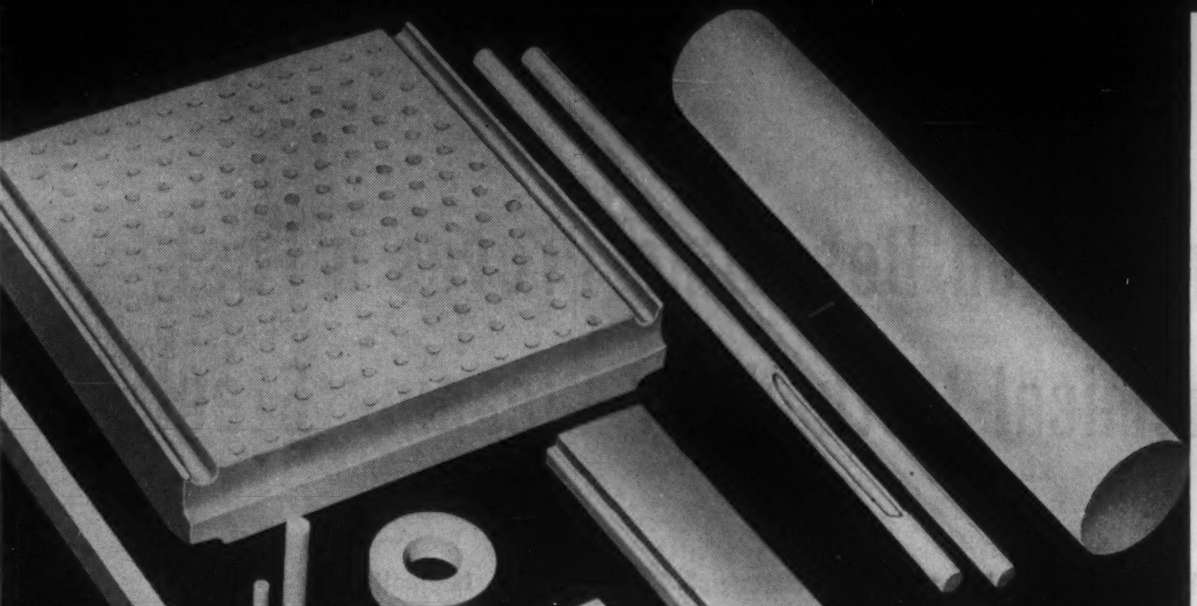
The pieces being descaled are hot rolled bars for axle shafts, made in two sizes. The smaller bars are 2¾ in. in dia, 39 in. long, and weigh 65 lb each, while the larger sizes are 3⅛ in. in dia, 39 in. long also, and weigh 85 lb each. The pieces are passed through the induction heating unit for descaling after heat treatment but preliminary to machining.

A frequency of 10,000 cycles per sec was used for the experimental work, and was adopted for the production work also. Power input must be high to obtain the required heating in a very short space of time; an input of 65 kw is used for the small bars and 75 kw on the large pieces. The work passes through the heating unit at the rate of 900 ft per hr, and the surface is heated to about 350 F. Under these conditions the scale pops off the surface of the bar cleanly, and at the same time the work is not heated enough to cause any additional oxidation. Power cost for cleaning approximately 900 ft of 3⅛-in. dia stock is $1.00. This low power cost, plus reduced handling costs, make induction descaling an economical means of cleaning.



Induction heating set-up showing bar stock passing through coil where scale is heated to cause it to "pop" from surface.

In addition to the descaling of bar stock before machining, the process has possibilities for the continuous descaling of strip, bars, rods, tubes and other simple forms at the mill. One of its greatest advantages is that it can be built into the production line, eliminating scale at a high rate of speed and without an acid disposal problem.



Applications for the new lithium ceramics include jet engine parts, nozzle inserts, furnace liners, combustion tubes and high temperature jigs and fixtures.

New Lithium Ceramics Have—

• High Thermal Shock Resistance
• Controlled Thermal Expansion
• Chemical Resistance at High Temperatures

—A NEW MATERIALS PREVIEW

by R. E. STARK, Vice President, and B. H. DILKS, JR., Engineer,
Stupakoff Ceramic Manufacturing Co.

● A SERIES OF NEW ceramic materials having a coefficient of thermal expansion that can be controlled by formulation of the ceramic, and having excellent resistance to thermal shock, has been announced by Stupakoff Ceramic & Manufacturing Co., Latrobe, Pa. The new ceramics are based upon lithium aluminosilicate, and are being offered under the trade name Stupalith.

In addition to the high resistance to thermal shock, a low coefficient of expansion is important for applications in which the materials are required to hold dimensions through a wide range of temperatures. Various compositions in the series can be produced with properties so controlled as to provide a range of coefficients of thermal expansion, from positive to negative. The ceramics are produced from blends of lithium-bearing minerals and clay or blends of other ceramic raw materials to obtain the desired ratio of lithia, alumina and silica.

Research work that led to the production of the commercial material was done by Floyd A. Hummel, and was announced in 1948. Lithium aluminosilicate compositions were studied as offering several desirable properties. Later development of this research showed that a range of compositions could be produced in which silica content was varied to provide a range of coefficients of thermal expansion. A practical upper limit to the amount of silica is reached at a point where free silica is present and undergoes a phase change upon heating or cooling through a critical temperature, rendering it useless as a thermal shock-resisting material. At the other extreme of the practical range, a composition with negative coefficient of expansion—that is, one that contracts upon heating—is found. The series of useful compositions runs from those having a very low expansivity through those of practically zero expansivity to those having a relatively large contraction upon heating. Thus, in the series are compositions on the silica side having a thermal expansion coefficient of 2 x 10^{-6} in. /in./°C in the range 70 to 950 F. At the other extreme of the series are compositions with a coefficient of thermal expansion of –6.25 x 10^{-6} in./in./°C.

Two Groups

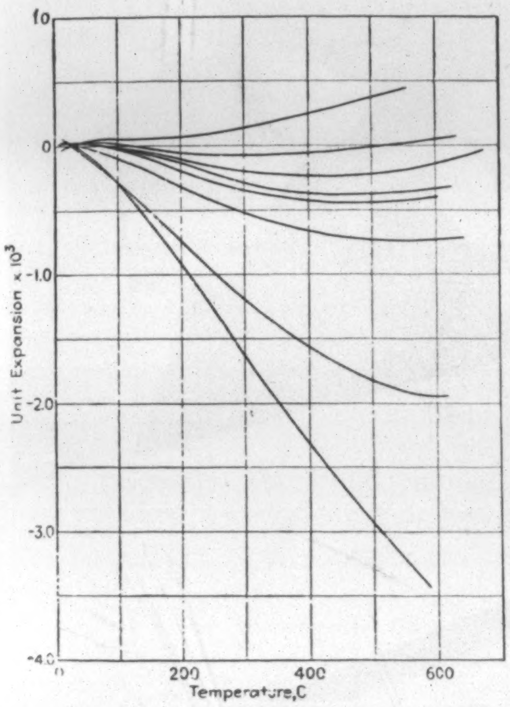
There are two principal groups of ceramics produced from the basic formula. The first of these have very low thermal expansion as their principal characteristic, and its members are referred to as "zero" thermal expansion compositions. The second group are nonporous compositions with low water absorption and low thermal expansion, and with good electrical properties to recommend them. The linear coefficients of expansion for the first group range from a high of 0.063 x 10^{-6} in./in./°C to a low of –0.063 x 10^{-6} in./in./°C. The second group have linear coefficients of expansion of the order of 0.8 x 10^{-6} in./in./°C in the temperature range from 70 to 950 F.

All testing done seems to show that the lithium ceramics will remain stable indefinitely at high temperatures. Samples held at 2000 F for periods of 30, 60, 90 and 120 days showed no perceptible change in specific gravity or other properties.

They have excellent chemical stability at temperatures below 1800 F, but will react with some material at higher temperatures. Suitable washes can be used to give protection at temperatures above 1800 F.

The excellent shock resistance of the new ceramics was illustrated in the laboratory by heating specimens to 2000 F and dropping them into liquid air. This treatment was repeated 100 times without ill effect.

The lithium ceramics can be formed by all the usual methods of fabricating ceramic parts, including pressing, extruding, casting or ramming. Parts can be made to very close dimensional tolerances, and precision parts can be machined or ground to size after firing. The materials from which it is made are plentiful and unrestricted. Prices of parts made of these ceramics are comparable with those of similar parts made in porcelain or steatite. Parts made from the lithium compositions range in size from tiny pressed or molded pieces weighing a fraction of an ounce to large rammed or cast pieces weighing several pounds.

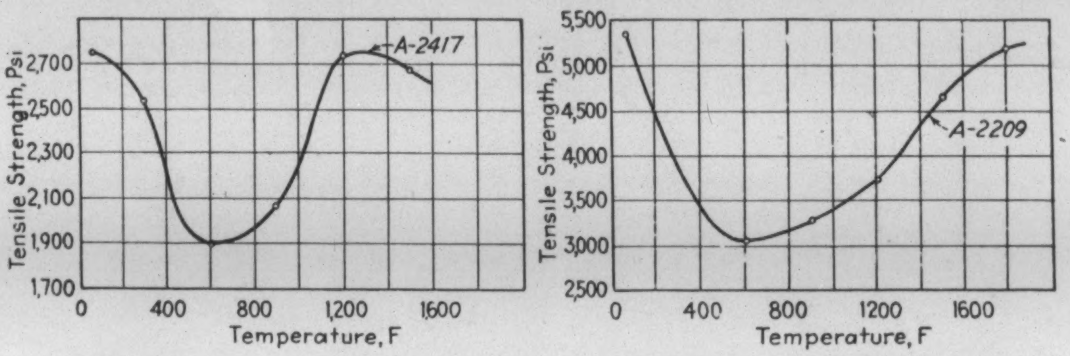


Typical thermal expansion curves of various Stupalith compositions.

Applications

Applications already found or under consideration take advantage of one or more of four features of the new ceramics. These are as follows:

1. Excellent resistance to thermal shock. This is utilized in such applications as kiln furniture, induction heating parts, high-temperature jigs, and wire-wound coil forms. Other uses under consideration are flame-resistant cookware, thermocouple protection tubes, etc.
2. Zero thermal expansion. Plug-and-ring gages, turbine blades, jet engine parts, nozzle inserts, and parts for internal combustion engines are some of the possible applications here.
3. Controlled thermal expansion. Furnace liners, thermostat core rods, etc., can make use of this property.
4. Chemical resistance at high temperatures. This property is of importance in such applications as pouring ladles for metals, combustion boats and combustion tubes for laboratory use, and pickling tanks.

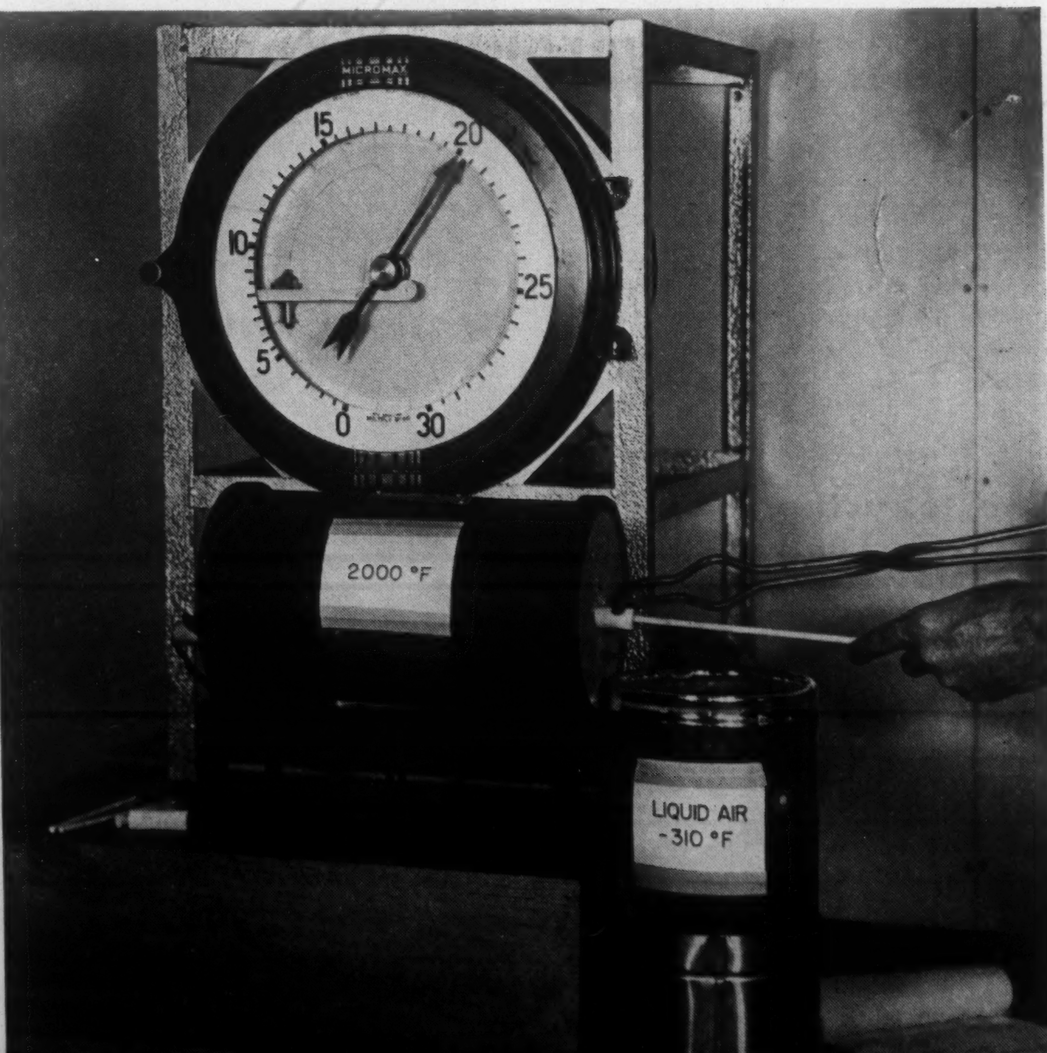


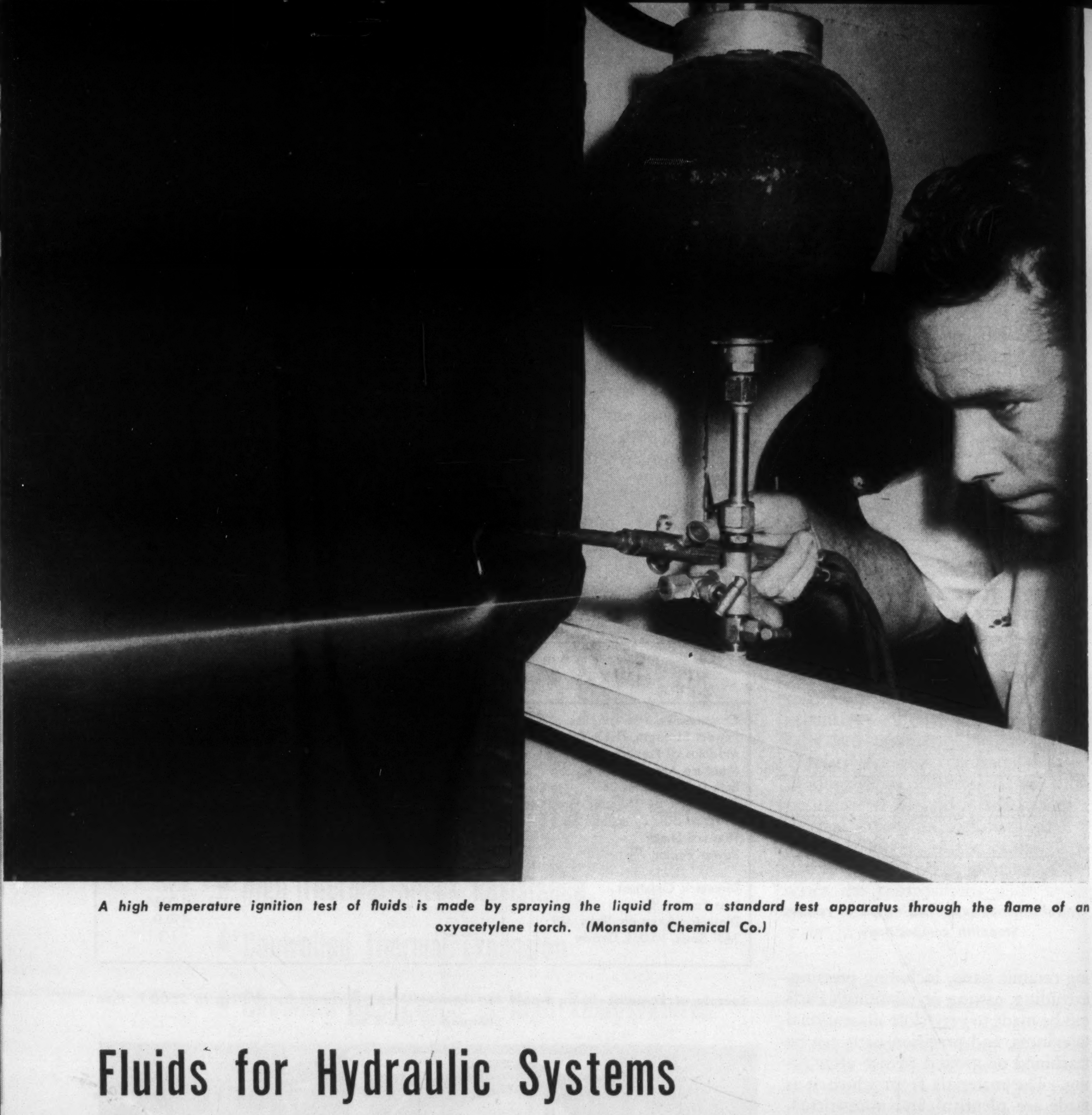
Tensile strength vs temperature for two of the new lithium ceramic compositions.

Properties of Stupaliths

	Typical "Zero" Expansion Body	Typical Nonporous Body
Compressive Strength, Psi	19,880	60,800
Impact Strength, Ft-Lb/Sq In.	0.90	1.40
Modulus of Rupture, Psi	4,250	8,000
Moisture Absorption, %	21.5	0.00
Bulk Density, Gm/Cc	1.60	2.34
Coefficient of Thermal Expansion, 20 to 500 C, in./in./°C	0.063×10^{-6}	0.85×10^{-6}
Thermal Shock	2300 F to cold water	900 F to cold water
Power Factor, %	....	Wet Dry
		0.492 0.424
Dielectric Constant	....	5.56 5.57
Loss Factor, %	....	0.0273 0.0236
Dielectric Strength, Volts/Mil	....	...... 450.0
JAN Spec. I-10, L Grade	....	I-3 I-3

Sample of Stupalith being tested for thermal shock resistance by heating to 2000 F, then plunging in liquid air.





A high temperature ignition test of fluids is made by spraying the liquid from a standard test apparatus through the flame of an oxyacetylene torch. (Monsanto Chemical Co.)

Fluids for Hydraulic Systems

—The Basic Types and Where to Use Them

by **KENNETH ROSE**, Western Editor, Materials & Methods

The exacting requirements of hydraulically actuated power and control mechanisms narrow the choice of fluid to a relatively small group of materials.

● WITH THE WIDE EXPANSION in the types of hydraulic systems and their fields of application has come more exacting requirements for the hydraulic fluids to be used in them. Beginning with the hydraulic press, in which water was used in a power-multiplying hydraulic system, hydraulic controls have spread to machine tools, welding equipment, holding devices, die casting machines, materials handling equipment, automotive and aircraft units, and many others. Combinations of electric or electronic starting, timing or measuring devices with hydraulic actuation of the part to be moved have been especially successful as design units.

The special requirements of hydraulic fluids for these uses narrow the possibilities to a relatively small group of materials, with little or no chemical relationship among themselves, but having in common certain properties that make them suitable for use in hydraulic systems.

Hydraulic systems can be used for power-multiplication, as in the hydraulic press; for remote actuation, as in the hydraulic brake in the automobile; for precision control, as in the hydraulic actuation of workholder or tool-holder in machine tools; or for actuation in automatic equipment, as in the automatic cycles of some die casting machines. In all systems, the hydraulic fluid serves only as a flexible and easily controlled means of transmitting motion or power. A single system can be used for several of the purposes given.

Selection Factors

Some of the considerations in the selection of a hydraulic fluid for a given application are:

1. Low volatility—The fluid should not evaporate quickly, preferably not at all, under conditions of service.
2. Viscosity—The fluid should have an ideal viscosity, high or low, at whatever temperature is best for operations of the system, and should have a high viscosity index, or small change of viscosity with change of temperature.
3. Service life—It should have good service life, as indicated by mechanical and chemical stability.
4. Specific gravity, or weight—Weight should be as low as is consistent with other requirements, so as to reduce inertia and pumping capacity requirements.
5. Flammability—The fluid should be preferably nonflammable. Flammability is best measured by service tests, but is indicated by autogenous ignition temperature, the temperature at which it will take fire without contact with flame; flash point, the temperature at which popping begins when a flame is passed over the surface of the liquid; and fire point, the temperature at which a flame passed over the surface of the liquid starts a fire that lasts for about 5 sec.
6. Noncorrosiveness — There should be a minimum of reaction with the metallic and nonmetallic parts of the system, including the gaskets and packing, hose, etc.
7. Toxicity and odor—The fluid should not be toxic, and should not have an objectionable odor.
8. Hydrolysis stability—Condensation of water in the system should not cause hydrolysis with possible attendant increase in acid number and corrosion of the system.

It is not always necessary that a hydraulic fluid should meet all of these considerations exactly. The material should meet them to a satisfactory degree under the conditions of use, and with due regard to price of the fluids. Thus, in a given application, if a part of the fluid should be lost from the system, if there is no danger of freezing, if there is a fire hazard, and if corrosion is not a serious problem, water may be the best fluid to use. Many machine tools having hydraulic systems use petroleum oils because they are noncorrosive, and flammability is not an immediate danger.

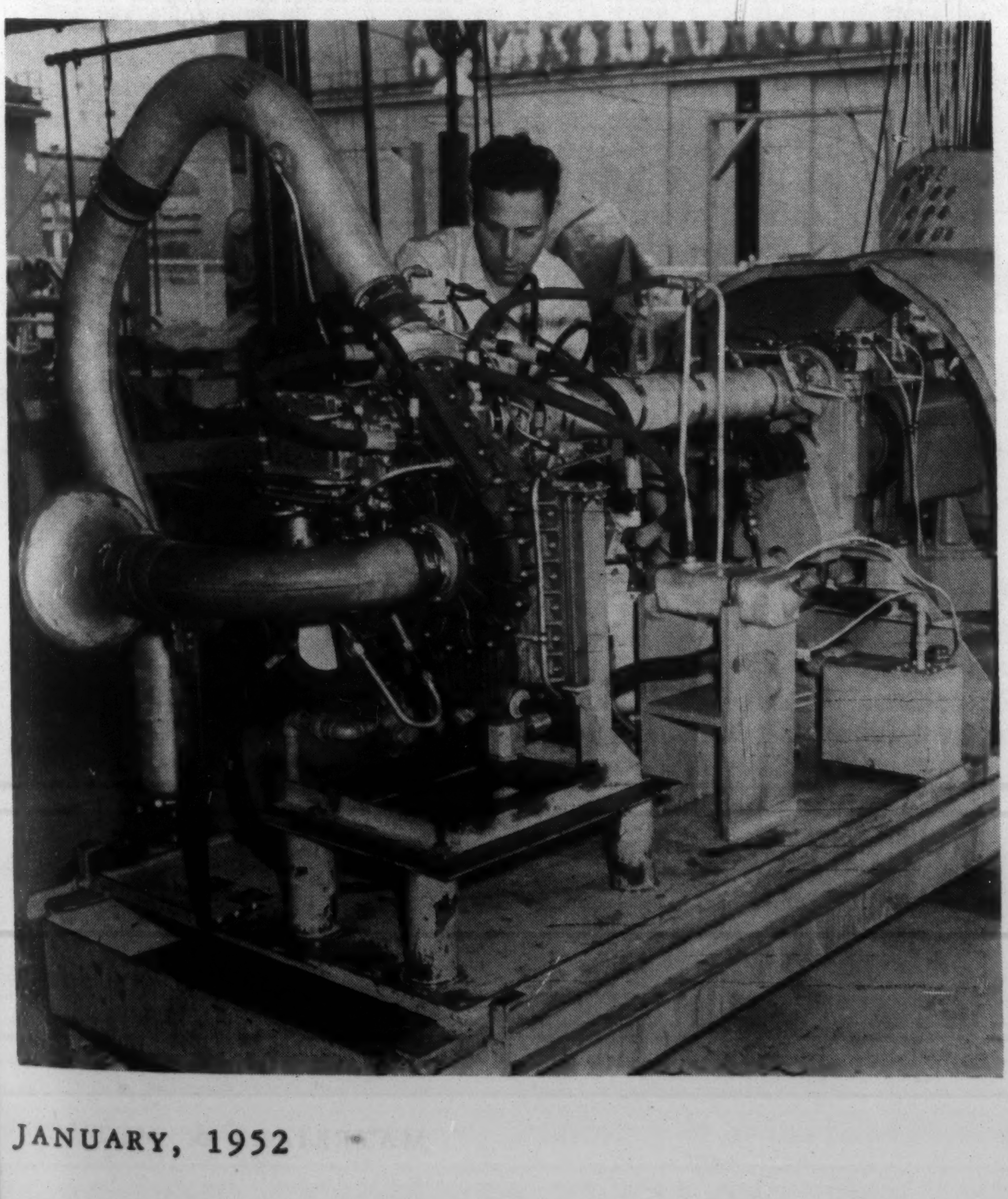
The problems associated with hydraulic controls become intensified in their use in aircraft, both civilian and military. The modern plane makes use of many types of hydraulic controls, including systems for actuating the wing flaps, for raising or lowering the landing gear, for braking the landing wheels, for operating the windshield wiper, and for steering the nose wheel. The cabin supercharger in aircraft with pressurized cabins and the expansion turbines for cabin air-conditioning also use hydraulic fluids. Necessity for withstanding a wide range of temperatures, including temperatures as low as —100 F; the need for nonflammability to reduce the fire hazard; the importance of light weight; and the avoidance of corrosive action, with flat viscosity curve over the range of service temperatures, demand a special fluid, and carry a premium price. They may cost eight to 12 times as much as low-cost petroleum fluid.

Types of Hydraulic Fluids

Hydraulic fluids are classified according to composition as follows:

Water-Base Types—These include water, water-ethylene glycol mixtures, and water-methanol mixtures; use of polymer thickeners, most commonly ethylene oxide derivatives, is gaining. They have rather poor lubricity, but are the lowest in cost of the hydraulic fluids. They tend to rust iron pipe and other iron in the system unless inhibitors are added. While the fluids composed entirely of water or with

A complete cabin supercharger from a DC-6 transport plane is used to test lubricants and hydraulic fluids. (Monsanto Chemical Co.)



very little glycol or methanol added are practically nonflammable, the mixtures with appreciable amounts of glycol or methanol become flammable if water is lost, as in vaporization of the fluid through a small leak. Addition of ethylene glycol or methanol to the water lowers its freezing point and gives the mixture a wider range of service temperatures. Ordinarily, water and the water-base types are most used in indoor machinery, where low temperature is not a problem, but a more recent type is used in aircraft.

Hydrolube, produced by Carbide and Carbon Chemicals Div., Union Carbide and Carbon Corp., is a proprietary fluid in this group. A new fluid of the water-base type, offered under the trade name H2 Hydraulic Fluid, has been approved by the Navy Bureau of Aeronautics for use in Navy aircraft. It is produced by R. M. Hollingshead Corp. Formulated with a minimum of 35% water, it is nonflammable as liquid or vapor. The materials added to the water give it good lubricity and make it serviceable to —60 F, overcoming two of the greatest disadvantages of water as an hydraulic fluid. It is nontoxic, has a pleasant odor, and is compatible with up to 10% of petroleum-base fluids. This last is important when changing fluids.

Oil-Base Types — Petroleum oils, adjusted to any desired viscosity within a wide range, are probably the most widely used of the hydraulic fluids. A few nonpetroleum oils, notably castor oil, are sometimes used. They are noncorrosive to all common metals, and many types of gasket and packing materials resist deterioration in contact with them, including most fibrous materials, leather, and the nitrile and chloroprene synthetic rubbers. Viscosity remains fairly constant at ordinary temperatures. The most serious defect of the petroleum-base fluids is their high flammability. Autogenous ignition temperature of most types is of the order of 500 F. This can be increased by the addition of "snuffers" —fire retardant chemicals intended to prevent continued burning of the oil. The petroleum-base hydraulic fluids are low-cost materials, and may be lower in cost than the water-base preparations to which substantial percentages of glycol or methanol have been added. They possess excellent lubricity. Where flammability is not a problem, they are the first choice. Hydraulic brakes on automobiles and trucks, hydraulic systems on machine tools, clamping systems on welding equipment, etc., are users of this type of fluid. Automobile braking systems use a castor oil with viscosity adjusted by the addition of alcohols, glycols or glycol ethers, though certain organic esters are finding use for this purpose.

Halogenated Organic Liquids — These materials are usually proprietary compositions sold under trade names. They cost five or six times as much as the petroleum-base fluids, are fire-resistant, have fair lubricity, and possess high breakdown temperature. While they have low vapor pressures, and so do not emit fumes at room temperatures, the fumes released at elevated temperatures are irritating and toxic. This is not a problem in a carefully enclosed system, but presents a danger in the event of breakage. The liquids used are usually chlorinated phenols, chloro-fluoro-chemicals, hexachlorobutadiene, etc. The chloro-fluorochemicals, including types offered under the trade name, Freon, are high in cost, but have flat viscosity curves and find use in certain military items, especially those involving low temperature.

Chlorinated phenols, offered in several types under the trade name, Aroclor (Monsanto Chemical Co.), have become standard liquids for hydraulic systems in die casting machines. They have autogenous ignition temperatures of the order of 1200 to 1300 F, are noncorrosive to mild steel, stainless steel, nickel and magnesium, but seem to attack many cuprous alloys. Asbestos packing and aluminum metal, Teflon and silicone gaskets have shown good resistance to these liquids.

Liquid Esters—These are sold as proprietary compounds. They are usually phosphates or silicates of organic radicals and are oily enough to have good lubricity. They are nonflammable and have a good range of service temperatures. Celluflex and Lindol HF (Celanese Corp. of America) have a tricresyl phosphate base with an autogenous ignition temperature of about 1150 F. They have been used for hydraulic systems in die casting machines for a number of years.

Pydraul F-9 (Monsanto Chemical Co.) is another phosphate ester used in die casting machines, glass-working machinery, etc. It has an autogenous ignition temperature of above 1100 F. All of these phosphate-base liquids are inert towards most common metals of construction, and gaskets made with Thiokol, butyl or silicone synthetic elastomer of the proper formulation hold up well. All have sufficient lubricity to be suitable for use as high-temperature lubricants. They do not give off irritating fumes in the event of a leak in the system while the fluid is heated.

Another of the esters used as a hydraulic fluid is OS-16 (Monsanto Chemical Co.), which offers its nontoxicity as a principal advantage. It has been used successfully in the control systems of coal-cutting machinery. Special butyl synthetic rubber hose and special gaskets of synthetic elastomers give good service when used in hydraulic systems filled with OS-16.

A fluid for hydraulic systems in aircraft has been developed by Douglas Aircraft Co., Inc., and Monsanto Chemical Co., and offered to the aviation industry by them under the trade name Skydrol. At present its use is confined to that industry. It costs about 12 times as much as ordinary petroleum-base fluids, has an autogenous ignition temperature of 1050 F and a pour point of —70 F, is non-toxic as liquid or vapor, weighs only a little more than water, has exceptionally good lubricity, is inert to all common structural metals, and has long service life. All types of oil-resistant synthetic rubbers swell in Skydrol, but special gasket and packing materials are available upon recommendation of Monsanto Chemical Co. and Douglas Aircraft Co.

Industry is beginning to recognize the potential danger of combustible hydraulic fluids in such applications as welding equipment, manipulating machinery for hot ingots and forging machines, where the fluid is ordinarily not a fire hazard, but may become so in the event of a burst hose connection or other breakage. A recent serious accident caused by ignition of oil spurting from a burst hose in a welder pointed up the danger. The die casting industry long ago began substituting nonflammable fluids for flammable materials in its hydraulic systems. In many applications there is no significant fire hazard even with combustible fluids, so there is little reason for considering the use of the more expensive fluids. Hydraulic brakes in automobiles use oil as the transmitting liquid, and here the combustible material would be a fire hazard only in the event of the vehicle taking fire, in which case the danger from the gasoline supply would far overshadow that from the oil in the hydraulic system.

The vast expansion of war and defense production has had a profound effect upon materials supplies and technologies. As an example, ships seldom required much aluminum, but now PT boats, such as the one shown in this U. S. Navy photo, have aluminum hulls.

Review
# of Materials Engineering Developments in
1951

by T. C. Du Mond,
Editor, Materials & Methods

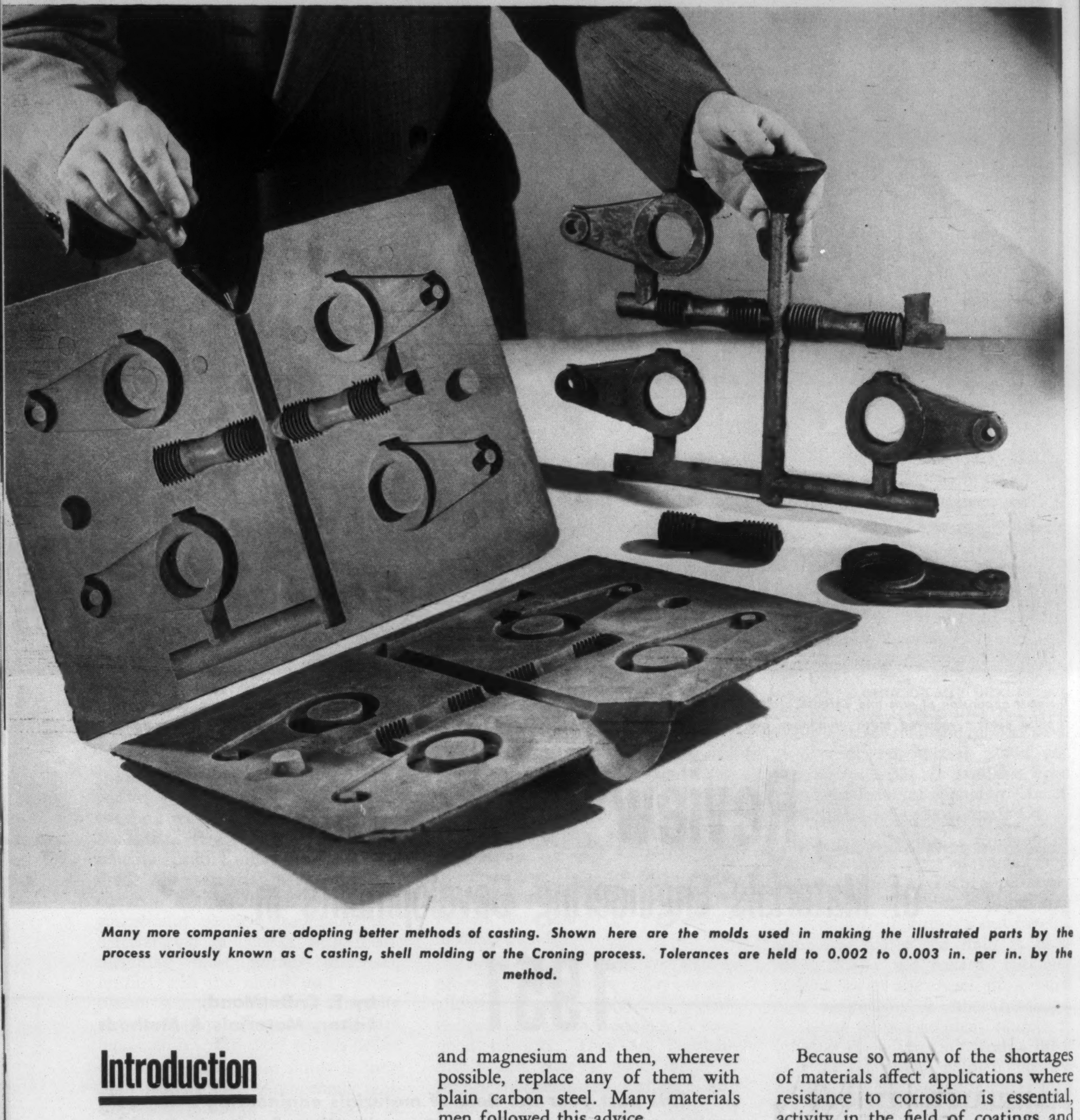
MATERIALS & METHODS MANUAL No. 78

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application.

JANUARY 1952

This past year the field of materials engineering was again replete with new developments and with refinements in older materials and techniques of materials processing. The outstanding ones centered, of course, about the serious shortages of many materials. In the following pages you will find a round-up of these major developments in:

- ***Irons and Steels***
- ***Nonferrous Metals***
- ***Nonmetallic Materials***
- ***Fabricated Parts and Forms***
- ***Finishes and Coatings***
- ***Heat Treating***
- ***Cleaning and Finishing***
- ***Welding and Joining***



Many more companies are adopting better methods of casting. Shown here are the molds used in making the illustrated parts by the process variously known as C casting, shell molding or the Croning process. Tolerances are held to 0.002 to 0.003 in. per in. by the method.

Introduction

The outstanding developments in the field of engineering materials during 1951 centered, of course, about the real and serious shortages of many critical materials.

Problems imposed by the Controlled Materials Plan led to many attempts at saving the scarce materials through simplification, standardization and the use of alternate materials and methods. Where metals are required, government men have recommended that alternate designs be available for copper, aluminum and magnesium and then, wherever possible, replace any of them with plain carbon steel. Many materials men followed this advice.

Again, as in the early 1940's, the needs of our military agencies have dictated many of our developments. Also, as in the past, many of these forward steps will not be revealed in detail until later. As an example, many things are being learned about titanium and zirconium which will soon be passed on to others in industry. Of course, some of the developments are being publicized as they come to fruition, as, for instance, high temperature ceramic coatings.

Because so many of the shortages of materials affect applications where resistance to corrosion is essential, activity in the field of coatings and methods of finishing has been feverish. A wide choice of alternate finishes is now available, and most automobile companies are ready to jump to one or another of them at a moment's notice. The signal will be the banning of copper as a plating material for nonessential products.

Where the many qualities of stainless steels are desired, but priorities are not high enough to get 18:8 steels, Type 430 stainless has been widely adopted. The shift from a chromium-nickel to a straight chromium stainless made necessary some changes in fabricating techniques. More and more plants have adopted the boron steels to get them around the alloy shortage. In other cases, a switch from alloy steels to the nodular irons or high-quality gray irons has kept production rolling.

Ceramics and refractory materials have come into their own during the last year. Their use has been as solid materials and in the form of coatings to permit metals to be used under severe conditions. Both types of applications can save materials that require large quantities of scarce elements. In the same general field, one-coat porcelain enamels have been developed which can be used on ordinary steels.

During the latter part of the past year, plastics have become available for more widespread use as alternate materials for metals. There are exceptions, of course, as in the case of the fluorocarbons, polystyrenes and nylon. Credit for at least a portion of the now available supply is due to increased manufacturing capacities. An easing in supply of some of the vital chemicals which had been earmarked for our synthetic rubber program also helped.

Although magnesium itself was not too readily available, a forward step was taken in a new field of application inasmuch as several automobile manufacturers adopted magnesium die castings to a limited extent. Currently, magnesium is being used on automobiles at the rate of 1000 tons a year. The use of both aluminum and magnesium is destined to increase considerably in the motor car industry, based on trends which became more strongly evident during 1951. Both of these materials have been strong in the heavy transportation equipment fields, so extension to passenger autos seems logical.

There has been more and more interest in titanium as more companies get into the field. There are now several company combinations operating in the reducing and primary metal fields and many more specializing in fabricating titanium components. During the year at least two reports were circulated which suggested that the price of titanium was going to come down drastically because of new reducing techniques. One report was premature and the second too recent to be evaluated. The reports do tend to confirm the fact that considerable research is going on to find better and, more important, cheaper means of providing metallic titanium.

The continuous casting of metals as a short-cut to the production of wrought products is becoming more wide-spread. Several copper-alloy producers have adopted the process, and it is reported that the commercial continuous casting of steel is almost a reality.

Whatever else might be said of 1951, it can be said that for the materials engineer, the last year might have been hectic but it was far from dull.

On the following pages, we review some of the major developments of 1951 as they affect the men who choose, fabricate and apply engineering materials.

Irons and Steels

Probably the most important development in irons and steels during 1951 was the enforced trend away from the more highly alloyed steels. By restricting the end use of nickel, columbium and other extremely scarce elements, government agencies made necessary the adoption of alternate materials. Most publicized and undoubtedly the greatest move to adjust to leaner alloys of steels was the acceptance of boron steels.

Boron steels themselves are not developments of the last year or two. Some companies have used steels in this group for five or more years. However, we now have a much wider group to meet a greater range of applications. Among those applications have been diesel locomotive crankshafts, heavy duty tractor axles, wrenches and cold headed parts.

The addition of boron to increase the hardenability of steel—and that is its only purpose—is most effective in low carbon steels. Boron steels, consequently, are best suited to replace the carburizing grades of alloy steels rather than, for example, spring steels.

Within recommended areas, boron steels have better forging, cold heading, descaling, annealing and machining qualities than the steels they replace. Development work is continuing on higher alloy steels which are not classified as boron steels, but which do contain boron, possibly in conjunction with some other alloying element or elements. One such steel is approved for such aircraft parts as heavy duty gears, shafts and pinions. Generally, lower alloy steels containing boron have the same core properties as the higher alloys steels they match in hardenability.

Some boron steels have replaced the National Emergency Steels of World War II. Series 80BXX and 81BXX are low nickel, chromium, molybdenum compositions in which boron has replaced about half of the alloy content needed in the 8600 and 8700 NE steels.

Actually, there are indications that many steel uses which were formally reserved for alloy steels can be handled equally well with carbon steels. At least one steel company has compiled a list which shows the satisfactory uses of carbon steels. The list includes many fussy applications for which materials men had formerly specified the more complex alloys.

Ductile irons have been given a wonderful opportunity to prove themselves during the past several months. In many instances they have been used to replace alloy steels with highly satisfactory results. The principal places in which ductile irons are being used as alternate materials is in the replacement of large steel castings and forgings. In one example, ductile iron was used to replace a 4140 steel forging in making a large spiral bevel gear. Quality controlled cast irons are also being relied upon to serve where more scarce materials had been used. The flexible joint in a locomotive steam line had been made of manganese bronze and then of stainless steel. Meehanite metal is now used with complete satisfaction.

The useful range of application of many steels is now being extended by the use of thin ceramic coatings. In some cases low alloy steels, so treated, are being used where heat, corrosion and abrasion resistance are essential and where formerly high alloy steels or special service alloys of other types were used. Likewise, the higher alloys are being used at still higher temperatures through the additional protection offered by ceramic coatings. (A more complete discussion of these coatings will appear in a later section of this review.)

Iron powders have again attained a position of prominence in the materials field. In one instance, iron powder rotating bands have been tried as a replacement for copper on moderately large caliber shells.

One of the newest developments has been the application of alloyed powder. In some instances, iron powders are used with copper powder as an infiltrant. Compacts of the two materials are placed together, with copper ranging from 3 to 12% of the total, and then sintered at slightly over 2000 F. At this temperature the copper melts, flows through the iron powder and, subsequently, welds the base structure together. The result is a strong, dense product with good ductility. Tensile strengths have been reported as ranging from 50,000 to 90,000 psi. One product so made is the impeller blade for a waste disposal unit. In this application, the copper-iron powder product is able to replace a high alloy part which could only be made through extensive machining.

There were several developments in the use of steels during the last year. Probably the most far reaching of these developments were concerned with both hot and cold extruding of steel. Several companies, both metal fabricators and makers of lubricating coatings used in extruding, have developed methods of producing cold extrusions. Processes currently in use are best suited to carbon and low alloy steels. Shapes are largely variations of hollow cylindrical vessels, although some different shapes are anticipated. Impetus to further development of these processes is given by an increased interest in the mass production of steel shell cases for Army ordnance.

Hot extruding is being developed rapidly for making more complex shapes in higher alloys of steels. One plant is expected to be in operation in this country by next spring.

In the spring of 1951 Curtiss Wright Corp. announced that it was producing large aircraft propellers through a process which is a variation of hot extrusion. Blades are made from chromium-nickel-molybdenum steel and extruded on a 5500-ton press. A 400-lb billet is first heated in a salt bath extruded to a certain extent, then reheated and returned to the press for expanding and tapering. After the general shape is attained, the final shape is achieved by flattening and then forming against a die. Materials requirements are reduced by 350 lb per blade (final weight 200 lb) by changing from the former method. In addition, only a minimum of machining is needed.

Steels being used in the Army shell case program are primarily SAE 1010 for low power shells, and heat treated SAE 1030 for other types of shells. Cold extruding and drawing are used to make these shell cases.

Scarcities of materials have placed added emphasis on conservation and reclamation of defective parts. Here are a portion of 100 carloads of enameled parts awaiting de-enameling by New Process D-Enameling Corp. Approximately 1200 tons of steel can be saved in 100 carloads of products.

Nonferrous Metals

Activity in nonferrous metals during 1951 was most fervent in the application of the metals in this group rather than in development of new alloys. However, there were some improved metals and some strictly new materials.

Carboloy Dept. of General Electric Co. waited until the Metal Show, late in 1951, to announce a new member of the cemented carbide group—chromium carbide. Although these materitals are really nonmetallics, their appearance and attributes are such as to merit discussion under metals.

Series 600, as the new compositions are called, chromium carbides are said to have excellent corrosion resistance, good resistance to deterioration at high temperatures, good abrasion and erosion resistance, and relatively light weight. They are also nonmagnetic.

Because of their resistance to oxidation at high temperatures, chromium carbides should find wide use up to 2000 F. Newness of the material prevents any definite statement as to the chief area of application. However, chromium carbides have been successfully tested in gage blocks and in ring and plug gages. In such uses wear and corrision resistance are definite assets. Other indicated uses are for such products as check valves.

Important today is the fact that raw materials for chromium carbides are much more readily available than the materials needed for other carbides, notably tungsten and cobalt.

Earlier, Carboloy announced another new material known as Hevimet. Hevimet has a density 50% greater than that of lead and is capable of resisting the penetration of radioactive rays. For this reason, Hevimet is used for gamma ray screens. The material is expected to be used extensively for balance weights on crankshafts, variable pitch propellers and similar moving parts. In balancing applications, Hevimet offers maximum weight in minimum size.

Two new nickel alloys were introduced during the last year. The first, Duranickel, had been developed and tested prior to the critical scarcity of nickel, and now can only be used on most essential applications. It has a nickel content of 93.7%, plus 4.4% aluminum and small amounts of copper, manganese, iron, silicon, carbon and sulfur.

Duranickel is a wrought material, slightly magnetic, with strength equal to heat treated alloy steel. Strength and hardness are said to be superior to other corrosion resistant alloys in the same price group. Strengths as high as 200,000 psi are achieved by cold working and age hardening.

Applications, generally, are those requiring a combination of corrosion resistance, hardness and high strength at both room and high temperatures.

Duranickel is used for springs, diaphragms, bellows, vacuum tube parts, dies and molds, fasteners, bearings, and for many other applications.

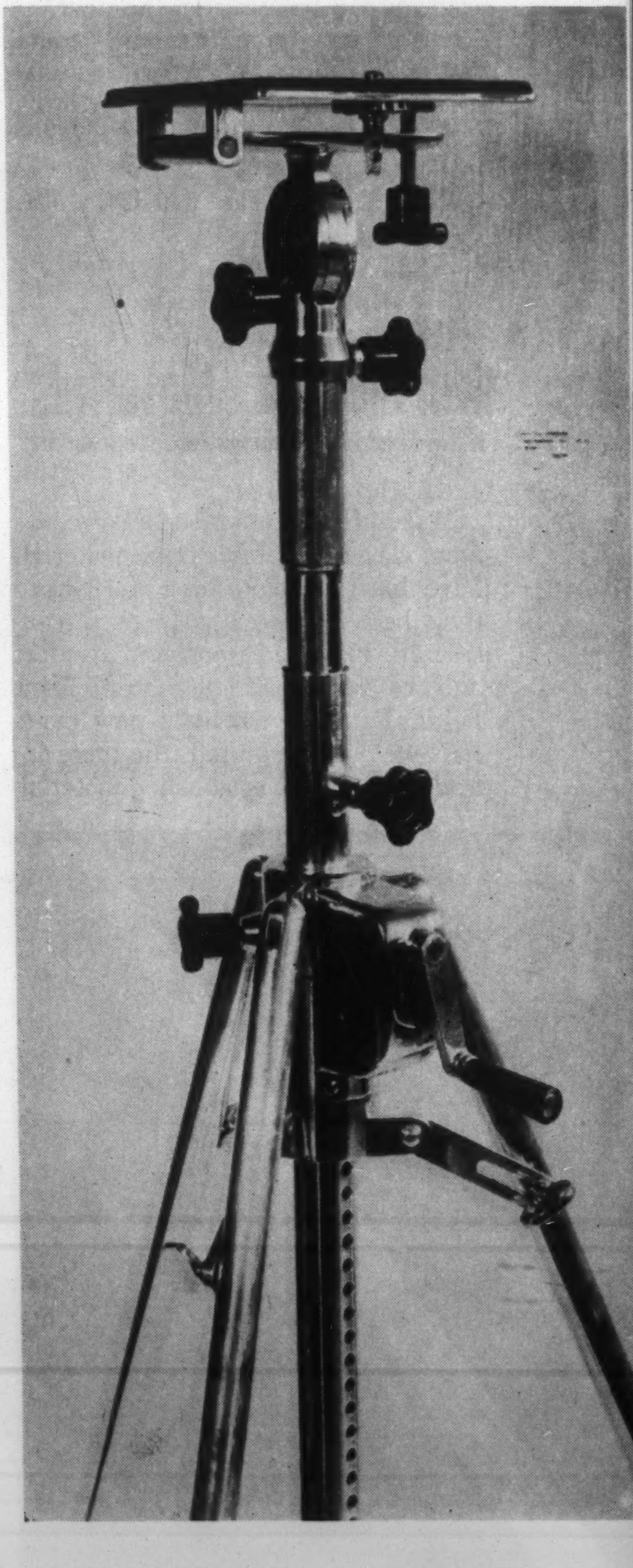
A variation of Duranickel is Permanickel, which has similar mechanical properties but different physical constants. Permanickel is preferred for spring requiring high electrical conductivity, parts needing good thermal conductivity, and magneto- strictive units which are operated under severe stress conditions.

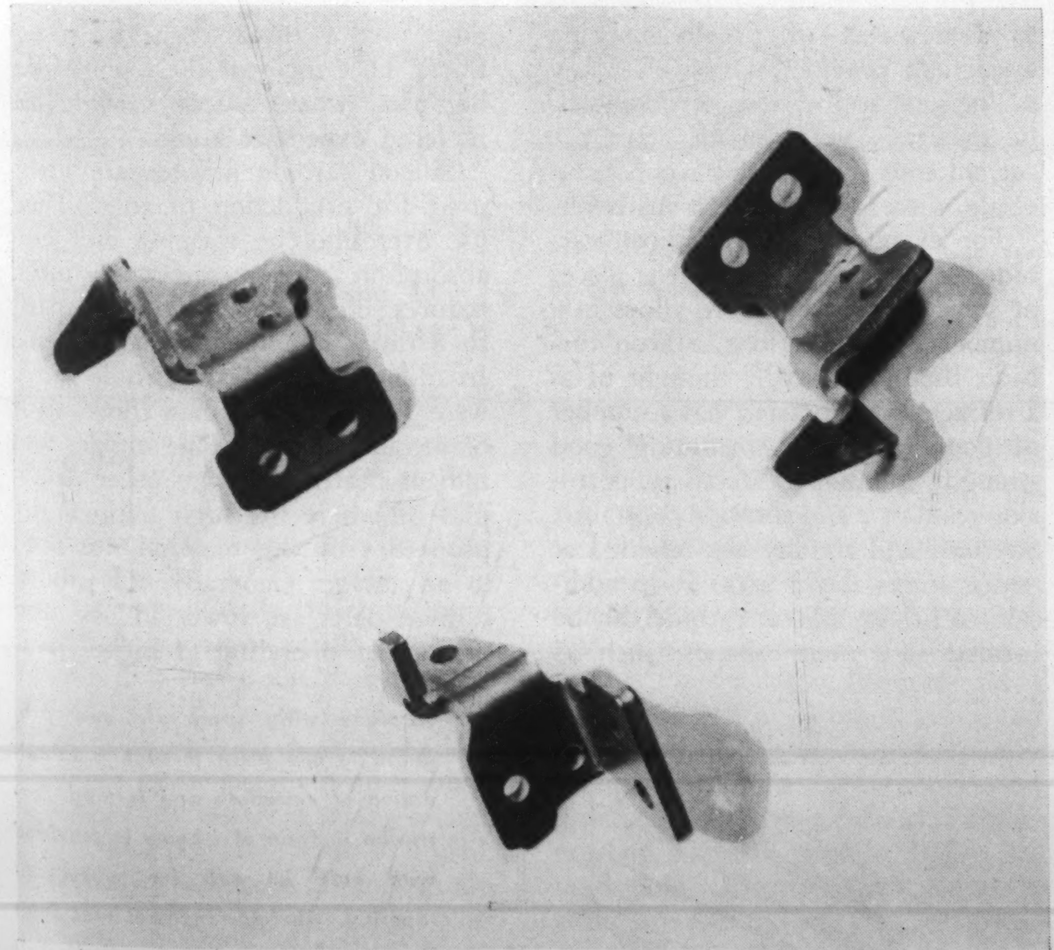
A new nickel alloy, developed to save nickel, is useful for high temperature corrosive applications. It is called Incoloy. The new alloy contains 35 nickel, 70% chromium, and iron, and is available in most standard forms. Incoloy is being used for some applications where 70% nickel alloys were used.

Two new aluminum alloys were made available during 1951, although one is still only available for limited use. Alloy XA78S, designated an aircraft alloy, has not yet been put into full production. It is said to be 10% higher in tensile and yield strengths than the strongest aluminum alloy now in use. The new alloy is of the 75S family and contains quantities of zinc, copper and magnesium. XA78S compares with 75S in elongation and fatigue properties, but has somewhat less workability.

For operating at moderately high temperatures, there is a new aluminum casting alloy designated ML alloy. This alloy contains small

In the field of joining, industrial adhesives are now looked upon with considerable interest because of the difficult jobs they are called upon to handle. In this tripod Araldite resins are used to bond many dissimilar metals to each other. In the assembly are ferrous and nonferrous, wrought and cast metals.





Heat treating has been called upon to make low carbon steels do the work once assigned to alloy steels. IBM, for example, through carburizes these electric typewriter parts made of low carbon steels.

amounts of copper, magnesium, manganese, chromium, titanium and vanadium, and is intended for use at temperatures in the 500 to 600 F range. At 600 F, ML alloy offers a tensile strength of about 17,300 psi.

Development of an interesting alloy was made known by Chemalloy Association. The material, called Chemalloy, is intended for dry bearings, fluxless welding and to dissipate heat from other metals. The alloy is made of a mixture of pot metal, manganese bronze, solder and a reverberatory slag. The slag is used as a chemical carrier. The alloy can be and is made from virgin metal, reclaimed metal or scrap. Chemalloy is said to have inherent lubricating qualities.

The need for saving scarce metal, plus a recognition of the worth of clad metals, has spurred the development of such combinations. Several sources are now offering copper-clad aluminum, in thin, almost foil-like gages up to thicknesses to be used as bus bar for electrical applications.

Newest of the clad metals use lead as the cladding material. Two products in this group are being produced by Knapp Mills, Inc. Ferrolum is lead bonded to steel and Cupralum is a marriage of lead and copper.

The first offers the combination of steel's strength and lead's corrosion resistance. Both clad metals can be used in those industries which must provide shielding against nuclear radiation.

Cupralum, of course, combines the corrosion resistance of lead with the electrical conductivity and heat transfer value of copper. In addition to being used in processes involving the rapid heating and cooling of acids, the clad metal is expected to be important in the electroplating industry. In the latter case, lead-clad copper anodes are expected to increase efficiency of certain plating processes by as much as 1000%.

During the last year, also, American Brass Co. made available a new wrought brass that is reputed to be stronger, harder and springier than ordinary drawing brass. Known as Formbrite, the new brass is highly ductile for deep drawing and upsetting. Formbrite resists abrasion and scratching because of its hard surface. As a result of having higher strength, the new brass can save material on some applications. For many uses a simple buffing is all that is needed to produce a bright, lustrous surface.

Efficiency in forming shapes from aluminum sheet has been vastly increased by working with heated metal at Northrup Aviation. By the new process, 20 parts are hot-formed in 1 hr as compared with 60 man-hours required to produce the same number of parts by former methods. More than 200 parts of the B-35 plane are hot-formed. In hot forming, 75S-T6 aluminum is made to have the workability of 75S-O by heating to 300 F before forming. Heating is done either by oil bath immersions or through electrical resistance heating.

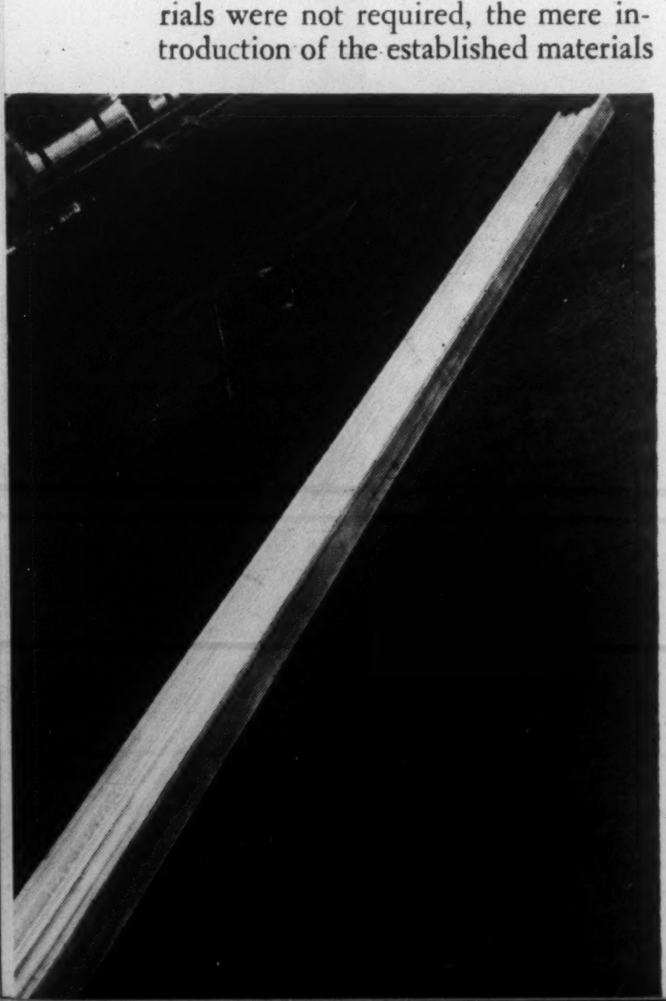
Other developments in producing parts of nonferrous metals will be discussed in the section of this review devoted to parts and forms.

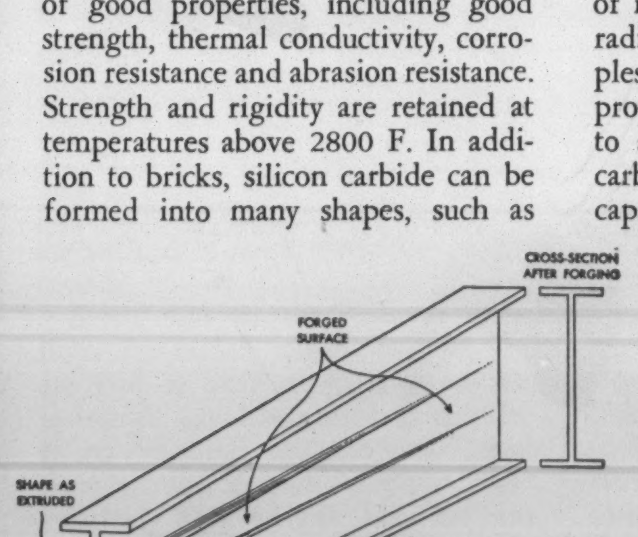
Nonmetallic Materials

As a result of metals scarcities, most classes of nonmetallic materials have been put into uses for which they had not previously been considered. Plastics, carbon and graphite and ceramics are all finding new fields. In many instances new materials were not required, the mere introduction of the established materials to a new set of problems being enough to provide an answer. Many of the new applications of nonmetallic materials will remain after the current emergency disappears because of the successful switch of materials.

For example, bonded silicon carbide refractories are taking the places of some high temperature alloys in a number of applications. Silicon carbide, though normally thought of as a refractory or abrasive, has a number of good properties, including good strength, thermal conductivity, corrosion resistance and abrasion resistance. Strength and rigidity are retained at temperatures above 2800 F. In addition to bricks, silicon carbide can be formed into many shapes, such as those used as throat shapes in rocket liners. That, incidentally, is one of the big uses, where silicon carbide has replaced expensive alloys.

Silicon carbide fixtures are being used for production brazing. Their use overcame the warping and heat absorption encountered with metal fixtures, eliminated sticking of parts to fixtures, and doubled fixture life. In addition, the silicon carbide pieces were less expensive than those made of metal. Silicon carbide muffles and radiant heater tubes are other examples of where the high temperature properties of the material are used to advantage. Generally, the silicon carbide parts are lower in cost and capable of operating at higher tem-




CROSS-SECTION AFTER FORGING
FORGED SURFACE
SHAPE AS EXTRUDED
SKETCH OF FORGE-TAPERED WING SPAR EXTRUSION

Airplane wing spars are now produced in one piece through a combination of extruding and forging. Extrusion in form of I-beam is provided with bulb in web for subsequent tapering. The development was joint work of Alcoa and McDonell Aircraft Corp.

peratures than the metals they replace.

Silicon carbide also is being used in wire guides for wire making where corrosion resistance is important; for furnace skid rails, as jackets on furnace rollers where abrasion resistance is important; and in many other applications where any or all of the good properties of silicon carbide are needed.

A new group of ceramic materials in which thermal expansion can be controlled through the mixture of the base materials is now available. The ceramics, outstanding for their resistance to thermal shock, are marketed under the trade name Stupalith. Illustrating the range of thermal expansion in the ceramics is the fact that some compositions actually contract upon heating. Stupalith can be formed by all usual methods employed with ceramics, including pressing, extruding, casting and ramming. Close tolerances are possible, and parts can be machined or ground to size after firing. In addition to the expansion and thermal shock properties, the materials are chemical resistant at high temperatures.

The ceramics are used for kiln furniture, induction heating parts, plug and ring gages, turbine blades, nozzle inserts, furnace liners, core rods, combustion boats, metal-pouring ladles and pickling tanks.

In order that potential users of lava products can carry on product development in their own plants, American Lava Corp. has made available Grade A lava. The material machines easily and can be used unfired. Electrical properties of the unfired lava approximate those of the fired material, but strength is low. Firing makes the product hard. Shrinkage is nominal, so dimensions can be held reasonably close.

In the field of plastics, important forward steps have been taken in supplying reinforced molding powders. Glass fibers are mixed with the basic plastic powder so that strength becomes evenly distributed throughout the shape. These materials come into being just as the problem of molding around glass fibers is being solved. Products so formed have exceptionally high impact strength and, therefore, can be used in many places where plastics had been excluded. One of the materials in this group combines alkyd resins with glass fibers. Because of the excellent electrical properties of the alkyds, many of the early applications are in the electrical and electronic fields.

The problem of welding unstabilized stainless steel has been solved by Crucible Steel by the simple expedient of water-cooling the weld area immediately after welding. Here the welder is using a swab to cool the weld zone.

It is expected that similar compositions will soon be available using some of the thermoplastic resins.

The usefulness of the fluorocarbons plastics is being extended by developments which have recently reached the commercial stage.

The Fluorocarbon Products Div., U. S. Gasket Co., is producing metal surfaced materials of the fluorocarbon group for such uses as capacitors and moisture-proof printed circuits. Fluorocarbon materials, such as Teflon, are used pure, or with other materials, such as asbestos, mica, glass fibers, ceramics and other filler materials.

Sheets of the plastics are then metallized on either or both sides with aluminum, boron carbide, copper, Alnico, monel, lead, mu metal, solder, tin, magnesium, iron, steel, molybdenum, Nichrome, bronze, zinc, brass as the precious metals. Joining of metals and plastics is permanent due to a fusing action and there is said to be no acute strain point.

A new bonding method for joining the fluorocarbon plastics to metals, rubbers and silicones is soon to be ready for widespread use. Extra strength or resilience can be provided in applications where the inertness of the plastics is desired. Gaskets for difficult service will probably be one of the most important uses of the new combination of materials. Many military and aircraft applications are anticipated where erosive and corrosive conditions are expected.

Cellular Hycar Pa-21 rubber is now being produced by Sponge Rubber Products Co. The material is somewhat like cellular silicone rubber in that it is intended for use at higher temperatures for grommets, pads, gaskets, shock mounts and similar items which must also resist oil, ozone and gasoline. Cellular Hycar Pa-21 can be used in intermittent service up to 400 F, and will stand up under constant 300 to 350 F temperatures for a solid week. Open or closed cell structure can be provided.

A new product for decorative surfaces is produced by metallizing acetate sheet. The sheet thus produced has a mirror-bright finish. To use, the sheet acetate is laminated to wood or other rigid material and then manufactured into such products as radio grilles.

Early in 1951, a rigid vinyl chloride resin — Geon 404 — was announced by B. F. Goodrich Chemical Co. Geon 404 can be formed into useful objects by deep drawing or vacuum forming, extruding and calendering. The new resin has high strength and resistance to breaking, and is light in weight. Vinyl chloride also has excellent corrosion resistance properties, and its electrical characteristics make it suitable for many insulation uses. Applications for Geon 404 include instrument cases and luggage, and tanks for corrosive liquids. Currently, because of limited production, the resins are being restricted to military and essential products.

In an attempt to utilize further the advantages of the polyethylene plastics, three new forming methods have come into being. One process is comparable with centrifugal casting of metals and is known as spin casting. A joining method permits a true fusion weld and involves the use of a filler rod of the same material. The third new method is a flame spraying process for coating metals with polyethylenes. The methods are all designed to both overcome the processing disadvantages and realize service advantages of the high temperature properties of the polyethylene family of plastics. Extension of the methods to other groups of plastics is being investigated.

Fabricated Parts and Forms

Through the combined forces of materials shortages and military needs, there have come about several recent developments in the manufacture and use of fabricated parts and forms. Among those developments worthy of being recorded are the widening use of castings made by the C-process; one-piece fabrication of tapered aircraft spars; the stamping of electrical circuits; the use of iron-powder shell rotating bands; and the impact extruding of aluminum.

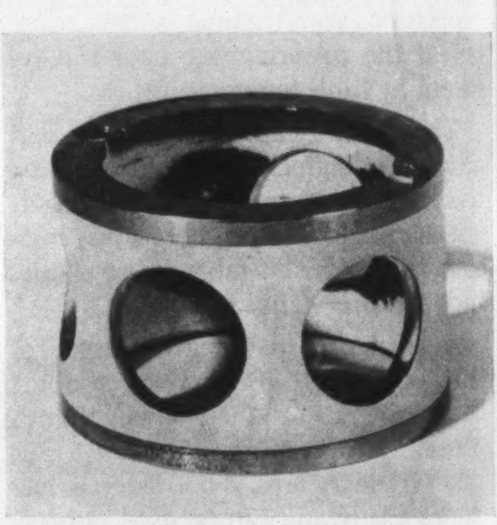
There is nothing spectacular or new about magnesium die castings, but the fact that they are now being adopted for automotive use is of great future importance. Future automobiles are expected to use much greater quantities of both magnesium and aluminum. In addition to the magnesium die castings, many more cast light metals are being planned. For example, an all-aluminum passenger car engine is being studied carefully, and cast magnesium wheels are being investigated for trucks and trailers. Too, sheet aluminum bodies for both passenger and commercial cars is anticipated in the not too distant future.

There have been two newsworthy developments in the field of impact extruding. First, magnesium is being impact extruded now by methods which compare with those used for other metals. Most magnesium alloys could be formed by impact extruding, but alloy FS-1 is best for all around use. Magnesium to be formed by impact extruding is heated to a point between 350 and 700 F and made to flow under pressure of 40 to 45 tons per sq in. Thus far, magnesium impact extrusions have been limited to simple shapes, such as cylindrical dry-cell battery cases and square cans. Indications are that the extrusions can be made with flanges, ribs and bosses, as is now done with other metals.

Recently an important move in impact extruding was revealed in the announcement that double-walled aluminum alloy parts are now being extruded. Alloys 2S and 3S are used to make double-walled parts up to 3 in. in dia by Alcoa for the U. S. Navy. The alloys are extruded cold. Formerly, to attain similar parts, it was necessary to weld two tube sections to an end plate.

A combination of extruding and forging is used to make tapered aluminum spars for aircraft use. The part as now produced replaces a composite assembly of riveted construction, and saves over 50 lb of material, and eliminates some 50 parts. By the process developed by McDonnell Aircraft Corp. and Alcoa, the part starts as an extruded I-beam with a bulb in the web. The beam is progressively flattened by forging so that the spar tapers from 15½ in. down to 10 in. After forging, the part is machined, heat treated and stretched to its final 13-ft length. Total weight when finished is 113 lb.

In the field of powder metal parts, what might be considered the most important advance of 1951 was the information that iron powder rotating bands for military projectiles are being actively considered to replace the copper bands which have been considered standard. Current planning would make the replacement effective on shells from 20 to 210 mm in size. Germany used similar rotating bands during World War II, and research has been continuing in this country since that time. Iron powder bands meet the requirements of ductility, strength, corrosion resistance and other special properties.



Porcelain enamels are being called upon to supplant metals for many difficult services. Aero Supply Manufacturing Co. combines a corrosion resistant metal body and an acid resistant porcelain enamel finish to make an aircraft fuel valve. Final dimensions of this precision part are achieved by grinding and lapping the porcelain.

Copper-impregnated iron powder

parts are also finding a prominent place in the defense program. Iron powders in compact form are bonded together during sintering at 2020 F by copper compacts which flow through the iron during the sintering process. Copper is used in the ratio of 3 to 12% in relation to the iron. Tensile strengths of copper-infiltrated iron compacts range from 50,000 to 90,000 psi, and density of the product approaches 97%. Ductility of parts so produced is said to be good. In one established application, the alloyed powders have replaced high alloy parts in impeller blades for waste disposal units. In addition to saving the scarce alloys formerly needed, the powder metal parts eliminate considerable machining that had been needed.

Another metal powder part development is the making of parts with interior pockets to serve as oil reservoirs. By providing the pockets, the self-lubricating properties of such parts as bearings and bushings can be extended by five to six times over the life of conventional parts. Openings can be varied in size and shape to meet the needs of the part. The so-called oil-well bearings are normally made of iron powders, but can and are made of bronze powders when they best serve the purpose. A variation of the oil-well bearing is a gear in which cavities can be made to extend into the teeth and thus provide a self-lubricating gear. The latter application is now somewhat past the experimental stage and should reach commercial production soon.

Somewhat reminiscent of the printed circuit method of making electronic parts is a process in which circuits are stamped, mechanically, from sheet metal and at the same time permanently attached to one or both sides of a plastic or other dielectric panel. Any type of sheet metal conductor can be used and can be stamped to any desired contour or in almost any pattern. The new method does away with the need, in many cases, of building up wiring harnesses, results in a more compact component, saves considerable hand labor, and reduces materials requirements and weight. Although there is a mechanical bond between conductor and panel, most assemblies also employ an adhesive for extra strength.

Currently, uncoated copper, tinned or silverplated copper, plain and tinned brass, silver and aluminum have been used as conductors. In addition to several types of plastics, wood, Masonite and tagboard have been used for dielectric panels.

Other developments having to do with fabricated parts and forms were discussed in the Iron and Steel and Nonferrous Metals sections of this review. They include the hot forming of aluminum sheet, hot extruding of steel propeller blades, and the widening use of steel for making cartridge cases.

Finishes and Coatings

Limitations in the use of nickel and copper in coatings for metal instituted a frantic race last year for a finish and coating to alternate for the usual electroplated coatings on steel. The result has been a flood of new finishes and finishing techniques. In addition, coatings of the ceramic type have been adopted as a means of providing high temperature corrosion resistance and, thereby, reducing the demand for some of the more scarce alloying metals.

Ceramic coatings as now applied to metals which are subjected to high temperatures are of the porcelain enamel family, but since they are more refractory, they are generally referred to as ceramics. The use of ceramic coatings has accomplished these things: (1) permitted irons and low carbon steels to be used at high temperatures; (2) increased fatigue strength, prolonged useful life at normal temperatures, and permitted the use at still higher temperatures of alloy steels. Among the chief uses of ceramic coatings at this time are exhaust pipes and mufflers for internal combustion engines. Ceramic coatings can be considered for many peacetime products, including space heaters, annealing covers, heat exchangers and many other products where operating temperatures range between 500 and 2000 F.

In the search for replacements for chromium-plated finishes such as are used on automotive bright work, several new metallic finishes have been developed. These are expected to be adopted rather widely if and when further restrictions on the use of copper are imposed. The finishes are referred to as metallic enamels.

One of the newer materials is chromium-carbide developed by Carboloy, which is expected to find many applications where heat and wear resistance are necessary. The part shown here is a gage anvil.

One such metallic enamel can be applied as a two-bake coating or three-bake finish. The latter system is for most severe service conditions. A phosphate treatment can be used for exterior applications, but is not otherwise needed. In the three-coat system a primer is baked on, after which a base coating is applied, together with the metallic pigment. After baking, a final clear coating is applied and baked.

The metallic coatings can contain aluminum pigment to provide a surface that resembles a satin chromium plate or a copper-bronze pigment that leaves a rich golden color.

Although intended primarily as a coating for metal, the metallic coatings can be applied over plastics as an alternate method to metallizing.

Also, a possibility as a replacement for the usual copper-nickel-chromium electroplated finish is white brass plate. An 80/20 zinc-copper alloy is plated from a bright cyanide bath. When properly applied, the coating has the desired brightness and is a reasonable color-match for the standard three-metal plating. Thus far, the method has not received complete approval of industry because of certain operational difficulties. Research to perfect techniques is proceeding and a solution seems probable.

A new finish for magnesium has been developed by military technicians and is, for the present at least, restricted to military applications. Known as HAE coating, the system is used to provide corrosion, abrasion and heat resistance to any commercial magnesium alloy. The finish is applied by electro-chemical means and results in a brown surface color which can be used alone or serve as a good paint base. Surfaces treated by the HAE method have withstood temperatures up to 2500 F for short exposure.

The first application of a new one-coat porcelain enamel is in finishing fluorescent lighting fixtures. The coating, developed by The Strong Manufacturing Co., is applied to nonpremium steel without a ground coat. In addition to the obvious economies of a one-coat system, the new coating also offers good acid resistance, high reflectivity, resistance to thermal shock, excellent resistance to abrasion and color stability after firing. Partially because of the thinness of the coating, Ti-Loc, as it is known, can be applied to parts which must later be sheared, bent, sawed, punched and drilled.

Protection against corrosion is afforded packaged steel parts by the use of crystals known as VPI. The crystals are volatile and emit a vapor which condenses upon the metal parts to be protected. VPI can be applied as a powder, dissolved in alcohol and sprayed on, used in a dip, or be impregnated in coating papers.

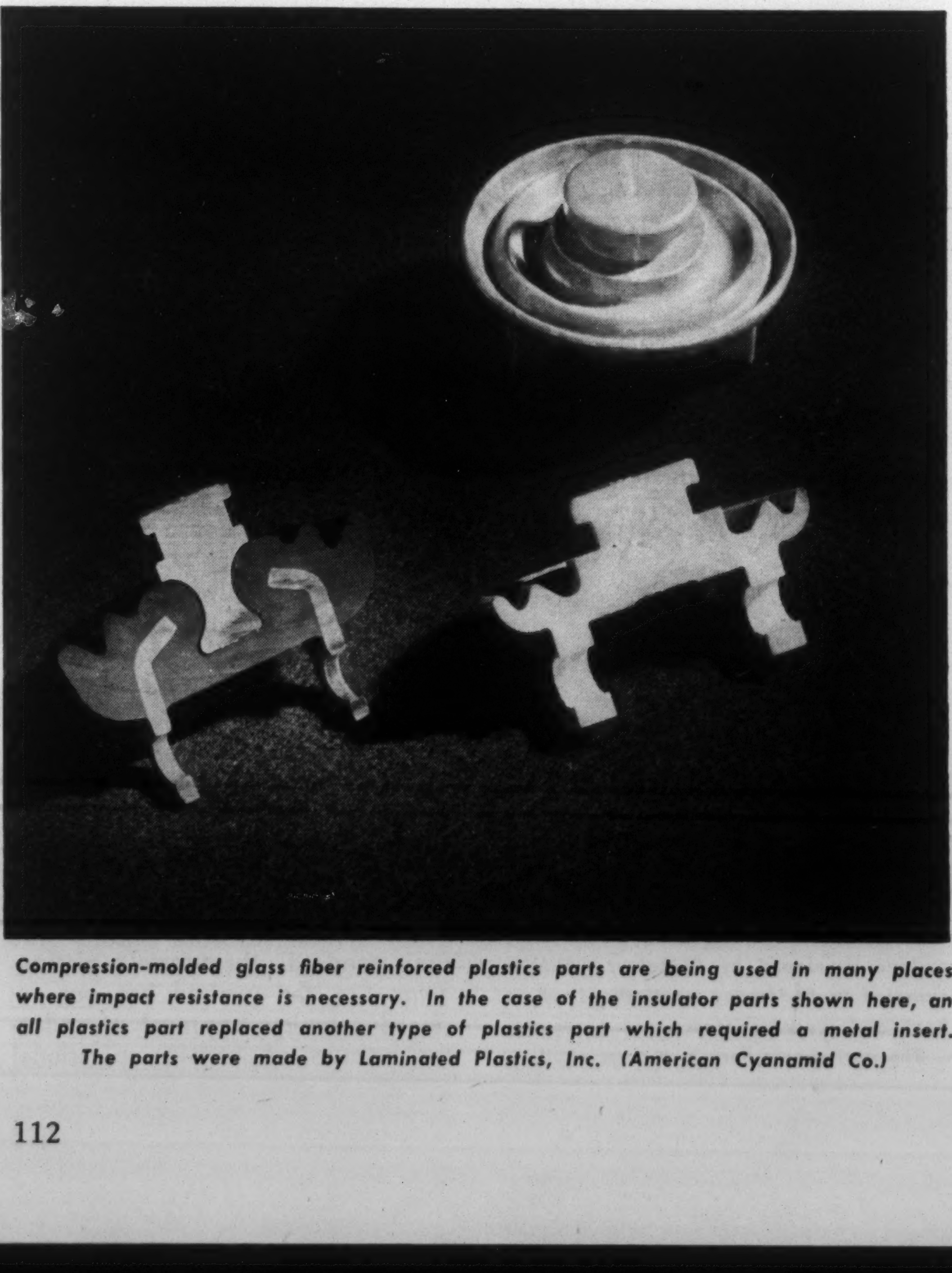
Heat Treating

Because of the unavailability of the more highly alloyed steels in recent months, there has been increased emphasis on heat treating to get the most out of available steels. Too, the boron steels have made necessary the adoption of better controls over the heat treating operations in plants which have adopted this series of steels.

The greatest difficulties in using boron steels have centered about the carburizing grades where usual quenching practices might produce unsatisfactory results. The problems include over-hardening of the core, or getting too soft a surface. Excessive hardening in the core and lack of hardness at the surface can be overcome by three methods: changing the alloy content; reducing the carbon content; or, slowing the cooling rate.

By quenching into a bath held at elevated temperatures, the cooling rate is reduced and, at the same time, the tendency is toward excessive hardenability. Somewhat the same effect can be achieved by quenching from a lower temperature. Insufficient hardening can usually be corrected by increasing the agitation of the quenching medium. A more drastic quenching medium might be necessary if hardening should be far below requirements, although excessive warpage can result from too drastic a quench.

Problems in quenching might be solved as a result of research work now being undertaken at Columbia University under the sponsorship of several industrial concerns, including several manufacturers of heat treating equipment. Stripped of technical verbiage, the objective of the research is to take the guess-work out of quenching. Should the studies being undertaken reveal desired information, it is believed that accurate heating and cooling cycles can be



Compression-molded glass fiber reinforced plastics parts are being used in many places where impact resistance is necessary. In the case of the insulator parts shown here, an all plastics part replaced another type of plastics part which required a metal insert. The parts were made by Laminated Plastics, Inc. (American Cyanamid Co.)

established for quenching steel of any shape and size.

Recently, a modification of the process variously known as step-quenching, martempering and marquenching, has been developed. In this process, developed by Richard F. Harvey, Chief Metallurgist, Brown & Sharpe Manufacturing Co., steel is quenched from above its critical temperature into a molten or heated bath held above the temperature of martensite formation for a time too short to permit transformation of the austenite at that temperature level, followed by hot working the steel while in a predominantly austenitic condition. Hot working can be done by blasting, peening, rolling, swaging, hammering, burnishing, forging or any other conceivable method of mechanical working. After mechanical working, the piece is air cooled to room temperature.

Advantages claimed for the new process include: greater compressive stress; higher surface hardness; no danger of cracking in peening; and, greater conversion of austenite to martensite. In effect, the new procedure combines the advantages of step-quenching and shot peening.

Several manufacturing plants are using a steam-atmosphere treatment as a means of increasing the corrosion resistance of steel. The process itself is not new, but its use for this type of application is. In some instances, the method is used to replace cadmium and in others, to save on chromium in applications where appearance is not the most serious consideration.

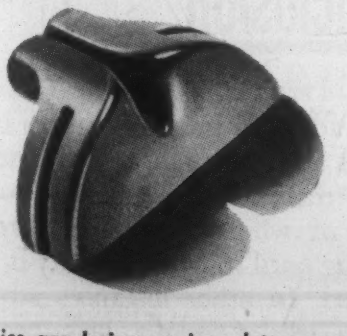
A relatively new use has been found for induction heating equipment. International Harvester Co. is using Tocco equipment to descale heat treated steel bars. A low temperature treatment causes the scale on the steel to expand and, subsequently, "pop" off the steel surface. As now used, the method of descaling is best suited to pieces of relatively even cross-section because at the most satisfactory temperatures, heat will not affect scale in recessed areas.

Cleaning and Finishing

Cleaning and finishing of metal products has always been a major problem of industry. The problem was no less acute during 1951 and was, in fact, intensified by real and threatened shortages of materials normally used in finishing.

As always, much of last year's progress took the form of refinements in previously developed cleaning and finishing methods. However, some latent processes have been revived and others which were not previously successful, have been made to work. Much attention has been paid, among other things, to the descaling of steels where a major consideration is the conservation of sulfuric acid. There have been three developments along these lines.

Many manufacturers are reverting to the oldest known method of removing scale from hot-worked steel—wire and small rod in particular. Before modern pickling methods were used, scale was removed from steel by mechanical means. More scientific mechanical methods are now being used whereby the metal is flexed to crack the scale which then falls off or is knocked off by brushes. Auxiliary benefits other than saving acid include better working conditions, reduction of the possibility of hydrogen embrittlement of the steel, and elimination of the problem of waste disposal. This method works best on parts or forms too small to be descaled by blast cleaning.

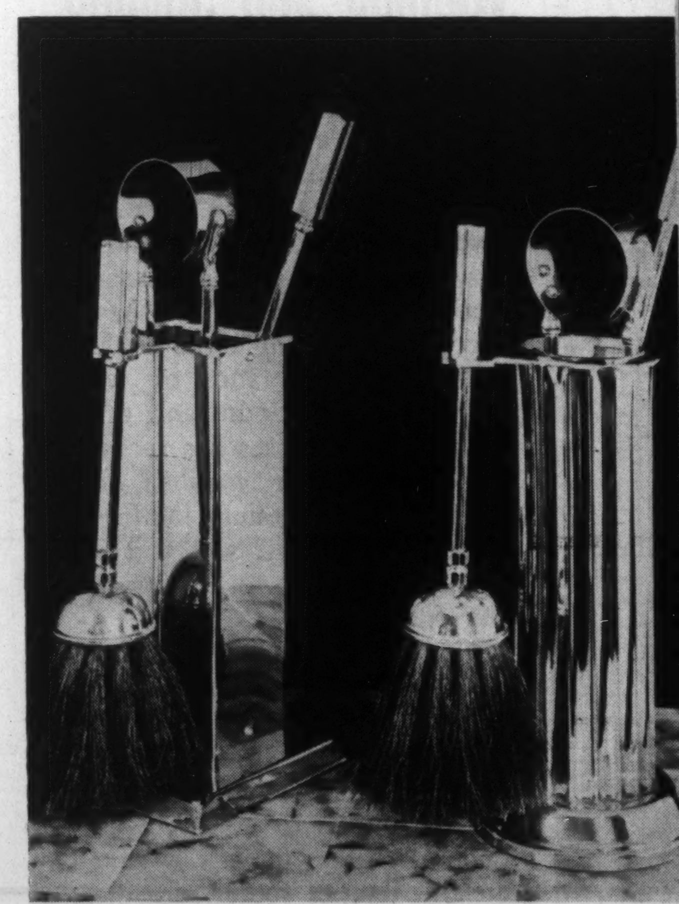


Ceramics are being assigned to many tasks where metals once were used, particularly where wear or heat and corrosion resistance are necessary. An example is this AlSiMag thread guide used in a textile mill. Parts are easily formed to required shape and dimensions.

Induction heating methods have recently been applied to descaling steel parts before machining. In a method developed by International Harvester Corp. and Tocco Div., Ohio Crankshaft Co., heat is applied to the part in a sufficient quantity to cause the scale to expand. Expansion causes the scale to "pop" from the steel surface.

Induction descaling works best on parts of uniform cross-section, which are descaled shortly after drawing and cooling. The relatively low temperatures used in the process might not affect scale held in crevices in the work. Currently, Harvester is using the method to descale hot rolled bars for axle shafts. Work passes through the induction heating unit at about 900 ft per hr, and the surface is heated to about 350 F. Under these conditions the scale leaves the surface cleanly, but the work is not heated sufficiently to cause further oxidation.

Still another descaling process is intended primarily for the descaling of carbon and low alloy steel forgings. The method was developed by



Much research has gone into finding new finishes for metals to not only save scarce materials, but also to improve surface quality and appearance. These parts have been plated with a tin-nickel alloy by methods developed by Tin Research Institute.

the Pennsylvania Salt Manufacturing Co. The method involves a pre-heat chemical bath in which parts are soaked prior to heat treating. Parts covered with forging scale are immersed in the room-temperature bath, composed of a patented compound dissolved in weak muriatic acid and water, for about 5 min. Parts are then heat treated at 1500 to 1600 F and soaked at temperature. The parts are then water quenched, at which time the scale blasts off. A cost reduction of 90% in descaling is claimed for the process. Also, no special atmospheres are required in heat treatment.

Several years ago, an electrostatic spray painting method was developed which proved successful in many applications. Now, Ransburg Electro-Coating Corp. has introduced a superior method which gives promise of not only providing a good surface finish, but also reducing the quantity of finishing material required for any given area. Lacquers, varnishes and enamels can be applied to metals. By the process, the coating material is electrostatically atomized before it leaves the spray head of the unit. The electrically charged, fine spray is attracted to the grounded material to be finished, resulting in an even deposit of the finishing material over the entire surface to be covered.

For many years engineers have been seeking a better method of electroplating iron on other metals. Recently Van Der Horst Corp. of America revealed its new iron plating process, which is intended primarily for building up worn or undersize parts before chromium plating. Vanderloy M, as the process is known, deposits pure iron on the piece to be plated under commercially feasible conditions. It is anticipated that the process will be extended to other fields of application, including electroforming. Currently, all plating is done in the company's plant, but other types of plating, when they come, will probably be done by other companies operating under a licensing arrangement.

Another area in which determined efforts have been made to attain better and more economical products is in porcelain enameling. The objective has been a one-coat enamel. One development of the year is a special coating material, which is described in the section of this review devoted to the latest developments in coatings.

Recently, Ferro Corp. and Republic Steel Corp. introduced a process in which only one enamel coat is required for durable porcelain enamel products. By the process titania-opacified enamel is used without the need of a ground coat or premium steels. Heart of the new process is a special pickling step which produces a sharp etch, leaving a rough surface. Sand blasting can be used instead of pickling. Nickel is then coated on the surface by chemical reduction. From this point normal porcelain enameling techniques are employed. The final porcelain enamel coating is only half as thick as ordinary coatings.

Welding and Joining

There have been relatively few new developments in welding and joining during the last year. As with several other processes, the most lasting heritage of 1951 is the refinement in techniques which have the effect of producing more certain results. The importance of welding magnesium, aluminum and titanium for aircraft purposes has focused attention on better ways of joining them. New magnesium joining techniques are on their way and should be made available to industry in the near future.

The problems of buying tin and the controls placed over its import by the government has again brought the low-tin solders into prominence. Although many engineers consider low-tin solders to be an expedient, there are some experts who advocate this type of solder regardless of the availability of tin. In many applications the so-called soft solders are better and more economical than the solders more generally used.

Columbium-bearing stainless steels were banned from all but the most essential uses during 1951. Therefore, many engineers charged with the responsibility of welding stainless steels were confronted with the problem of welding unstabilized stainless. Titanium stabilized stainless is not readily welded by arc-welding means using electrodes of the same analysis.

Overcoming the problem of welding the normal grades of stainless has been accomplished by engineers of Crucible Steel Co. by immersing the weld area in water as soon as is possible after the weld is made or frequently during welding. By cooling quickly, the weld area can be cooled to below 800 F and thereby prevent serious carbide precipitation. Water can be be applied by hose or by swabbing and wetting continued until all color disappears from the weld zone. By this method, types 302, 304 and 316 and similar grades of stainless can be welded. When thin sheet is being welded, cooling can be achieved by an air blast.

Through a development of Lincoln Electric Co., it is now possible to perform hidden-arc welding on plate in any position from flat to vertical so long as the joint itself is horizontal. Formerly, the method could be used only on down hand welding. Too, the new method permits welds to be made from both sides of the joint simultaneously. Welding time can be reduced by 50%, and smaller electrode wires suffice. The method of welding can be used on straight or irregular contours without the need of back-up strips.

Conclusion

In addition to the advances in materials and their fabrication described here, there have been many others, most of which will have to remain unsung until military security is again relaxed. In other instances advancement, while certain, has been so minute as to escape attention at the present time. In any event, the review as presented here will provide the highlights of 1951 for those whose interest is centered about the selection and application of engineering materials.

Materials & Methods

Materials Engineering File Facts

NUMBER 221
January, 1952

MATERIALS: General

Comparison of Corrosion Properties of Zirconium, Titanium, Tantalum, Stellite No. 6 and Type 316 Stainless Steel

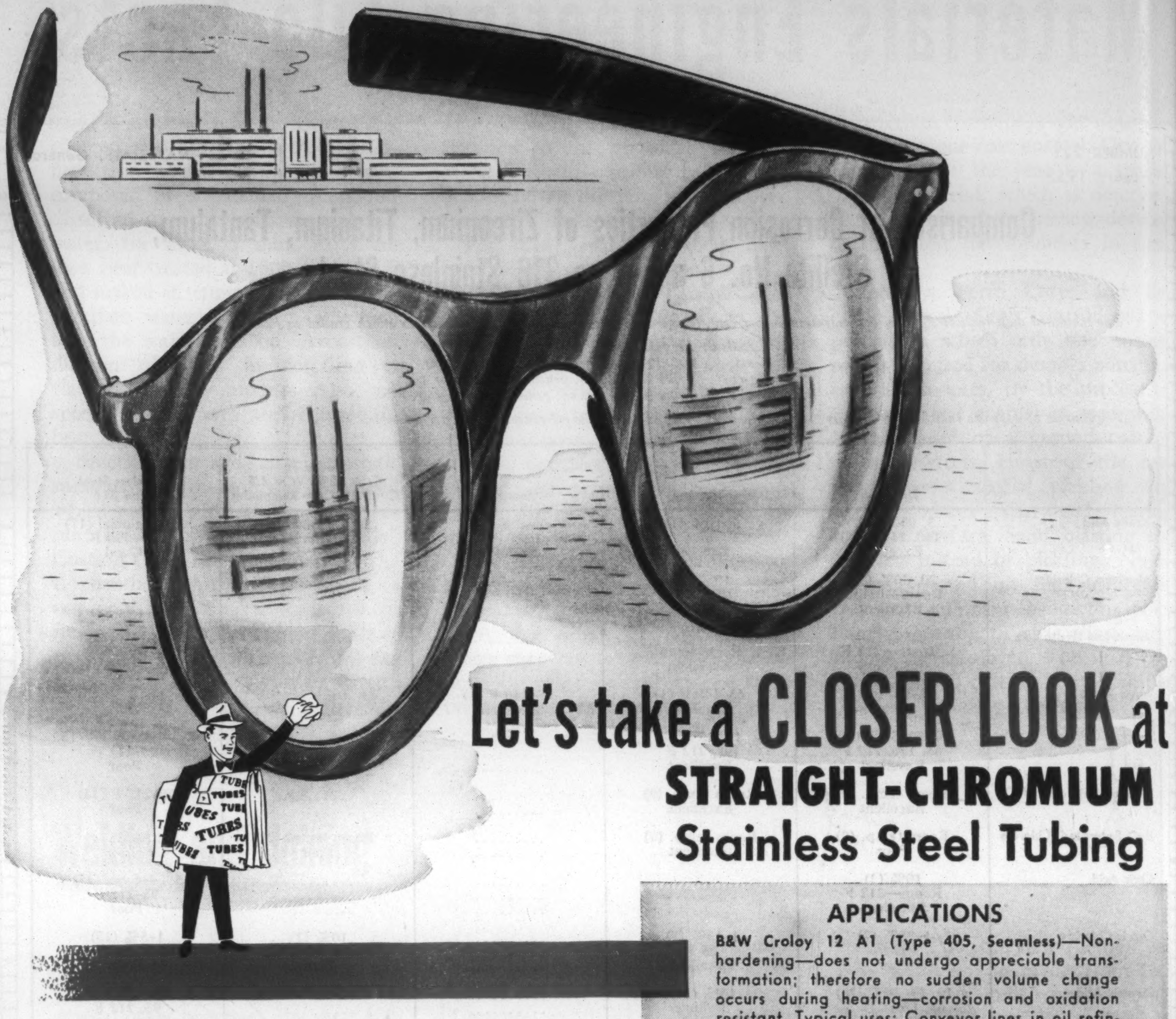
The tabulated data include solution concentration in per cent, temperatures in degrees F, and resistance to attack graded as follows:

Excellent: Less than 0.005 in. penetration per year
Good: 0.0005 to 0.005 in. penetration per year
Fair: 0.005 to 0.010 in. penetration per year
Poor: More than 0.010 in. penetration per year

The sources of data are indicated by numbers in parentheses, corresponding to the references listed after the table.

	Zirconium	Titanium	Tantalum	Stellite #6 Cr = 30%, W = 4.5 C = 1.10, Co = Remainder	Stainless Steel Type 316
Acetic Acid	5, 99.5% (7) 140, 212 F (6) Excellent	5, 10% (14) 68 F Excellent	All % (2) 68–735 F Excellent	10%—conc. (2) Boiling Good	5%—glacial (17) 95–390 F Good
Aluminum Chloride	20, 30% (20) Room—boiling Excellent	10% (10) 95, 212 F Excellent	....	....	....
Ammonium Hydroxide	28% (2) Room—212 F Excellent	28% (19) Room temp. Excellent	....	....	All % (15) .... Good
Aqua Regia	65–140 F(1) Poor	65–140 F (1) Excellent	65–140 F (1) Excellent	....	....
Calcium Chloride	20, 30, 50% (20) 68, 120, 212 F Excellent	10, 25% (9) 95, 212 F Excellent	....	....	5%—saturated (15) 95–212 F Poor
Chlorine Saturated H_2O	Room temp. (9) Excellent	Room temp. (9) Excellent	....	....	95–212 F (15) Poor
H_2O Saturated, Chlorine	Room temp. (9) Poor	Room temp. (9) Excellent	....	Room temp. (2) Poor	....
Citric Acid	10% (2) Room—212 F Excellent	....	....	....	5%—conc. (15) 95–212 F Poor
Cupric Chloride	1–25% (7) 95 F Poor	1–15% (8) 95 F Excellent	....	10% (2) Room—boiling Poor	1–5% (15) 70 F—boiling Poor
Chromic Acid	10, 20, 30% (20) 68, 120, 212 F Excellent	10% (14) Boiling Good	....	....	10–50% (15) 95, 212 F Fair to poor
Phosphoric Acid	10–85% (6) (2) (1) Room—212 F (3) Excellent to fair	1–85% (8) (1) (11) 65–212 F Excellent in dil. at room—otherwise poor	85% (2) (1) 290–410 F Excellent	38% (2) Boiling Good	10–85% (15) 68 F—boiling Poor
Sodium Chloride	3% (6) (4) 95 F Excellent	3% (6) 95 F Excellent	....	....	5% (15) 68 F Good
Sodium Hydroxide	10, 50% (20) Room—212 F (2) Excellent (15)	10, 40% (11) (14) 175 F—boiling Good	5, 40% (2) 212, 230 F Dilute-excellent 40%—poor	10% (2) Boiling Poor	All % (15) 175–600 F Excellent except in dil. boiling
Sulfuric Acid	10–96% (2) (6) (1) 65–212 F (3) Excellent in dilute Poor in hot conc.	5–65% (19) (1) (3) 65–95 F (10) (6) Dilute—good (11) Conc.—poor	20%—conc. (1) (2) 65–570 F Excellent	10% (2) Room—boiling Excellent at room temp. —poor at boiling	25%—conc. (15) Good at 68 F Poor at high temp.
Tartaric Acid	10, 25, 50% (20) 68, 120 F—boiling Excellent	50% (9) 95 F Excellent	....	....	....
Methyl Alcohol	99% (12) Boiling Excellent	....	....	....	....
Ethyl Alcohol	95% (6) Boiling Excellent	95% (6) Boiling Excellent	....	....	....
Carbon Tetrachloride	100% (20) Room temp.—120 F Excellent*	1–99% (14) Boiling Excellent	....	....	Room temp. (2) .... Good
Tannic Acid	10% (20) Room temp.—boiling Excellent*	25% (9) 95 F Excellent	....	....	....
Ferric Chloride	2.5–30% (4) 65–212 F (7) Poor (5)	1–20% (8) 65–212 F (10) Excellent (1)	5–30% (13) 65 F—boiling (1) Excellent	10, 30% (2) Room—boiling Poor	1–5% (15) 70 F—boiling Poor
Formic Acid	90% (7) (20) 68, 120 F—boiling Excellent	25–90% (10) (9) 95 F—boiling Excellent	90% (7) 212 F Excellent	....	5% (15) 160 F Fair to poor

(Continued on page 117)



Let's take a CLOSER LOOK at STRAIGHT-CHROMIUM Stainless Steel Tubing

Present restrictions on nickel have cut production of austenitic stainless steel tubing far below demand. If this critical shortage of nickel-bearing stainless tubing is compelling you to find other suitable grades, you should take a closer look at the straight-chromium analyses.

Readily available in quantity from B&W are pipe and tubes of the four non-nickel-bearing types listed at the right with typical uses. These ferritic and martensitic steels are magnetic at ordinary temperatures after all conditions of heat treatment, have relatively high oxidation resistance at elevated temperatures, and resist attack by many corrosive media. With certain modifications in procedures, they can be satisfactorily fabricated by all methods applicable to austenitic grades.

For both pressure and mechanical applications, tubes of straight-chromium stainless analyses are worthy alternates for hard-to-get nickel-bearing stainless types. Would you like a copy of TDC-140 containing technical data on these easy-to-get grades of stainless tubes? Ask Mr. Tubes—your B&W Tube Representative—about their suitability for your applications.

APPLICATIONS

B&W Croloy 12 A1 (Type 405, Seamless)—Non-hardening—does not undergo appreciable transformation; therefore no sudden volume change occurs during heating—corrosion and oxidation resistant. Typical uses: Conveyor lines in oil refining and chemical processing, heat exchanger tubing, boiler tubing in mercury heat cycle, catalytic oil cracking processes where fins have been welded to tubes.

B&W Croloy 12 (Type 410, Seamless and Welded)—Hardenable—moderate corrosion and heat resistance. Typical uses: Machinery in the chemical and food processing and packaging fields.

B&W Croloy 18 (Type 430, Seamless and Welded)—Sufficient ductility for forming simple parts—good corrosion and oxidation resistance—can be polished or buffed to pleasing finish. Typical uses: Conveyor lines in chemical processing field; condensers and piping in production, transportation, and storage of nitric acid and in nitrating operations involving mixed acids; furnace parts; retorts; ornamental structures.

B&W Croloy 27 (Type 446, Seamless)—Corrosion resistant—excellent heat resisting qualities. Typical uses: Furnace parts, heat interchangers, kilns, pyrometer protection tubes, soot blower elements, dehydrogenation equipment in chemical and oil refining fields. Also well suited for glass sealing applications.

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
General Offices & Plants
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. Cleveland 14, Ohio • Denver 1, Colo. • Detroit 26, Mich. • Houston 2, Texas • Los Angeles 17, Cal. • New York 16, N. Y. • Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Cal. • Syracuse 2, N. Y. Toronto, Ontario • Tulsa 3, Okla.

B&W SEAMLESS and WELDED TUBES

NUMBER 221 (Continued)

COMPARISON OF CORROSION PROPERTIES

	Zirconium	Titanium	Tantalum	Stellite #6 Cr = 30%, W = 4.5 C = 1.10, Co = Remainder	Stainless Steel Type 316
Hydrochloric Acid	Dilute—excellent at all temps. (1) (2) Conc. at room—exc. conc. at boiling—poor (3)	5%—conc. (1) (3) (8) 95–212 F (10) (18) Poor	19%—conc. (1) (2) 65–212 F Excellent	10%—conc. (2) Room—boiling Poor	Dry, moist (15) 68 F (19) Poor
Lactic Acid	5–85% (4) Boiling Excellent	85% (9) 95 F—boiling Excellent	....	....	5, 10% (15) 95 F—boiling Poor
Mercuric Chloride	1%—saturated (5) 95–212 F (7) Excellent (2)	1%—saturated 95–212 F (10) Excellent	Saturated at 212 F (7) Excellent	....	0.5%–2% (15) 70 F—boiling Poor
Nitric Acid	10%—conc. (2) (1) 65–212 F (3) (12) Excellent (6)	5%—conc. (1) (3) 95–212 F (10) (7) Good (11) (16)	Conc. (1) (2) 65–185 F Excellent	Dilute—excellent (2) .... Conc.—poor	Dil.—excellent (17) Poor in conc. (2) at boiling (15)
Oxalic Acid	1–25% (5) (7) (2) 212 F (4) Excellent	1–25% (9) 95, 212 F Poor	Saturated (2) Room—205 F Excellent	....	10–25% (15) 70 F—boiling Poor
Phenol (Carbolic Acid)	25, 50, 100% (20) 68, 120 F—boiling Excellent	....	Saturated (2) Room temp. Excellent	....	C. P. & raw (13) Boiling Good
Potassium Hydroxide	10, 20, 30, 40% (2) Room—212 F (20) Excellent	....	230 F (2) 5%—excellent 40%—poor	....	20, 30% (15) 68 F—boiling Good
White Fuming Nitric Acid	Room temp.—160 F Good (20)	Room temp.—160 F Excellent (20)	....	....	....
Red Fuming Nitric Acid	Room temp.—160 F Poor (21)	Room temp.—160 F Excellent (21)	....	....	....
Mono-Chloro Acetic	100% (4) Boiling Excellent	100%—boiling (4) .... Excellent	....	....	....
Hydrogen Peroxide	10%* (20) 120 F Excellent	Room temp.—30% (12) C.P.—poor A.C.S.—excellent	....	....	....
Ammonium Sulfate	Saturated* (20) 120 F Excellent	....	....	....	10% (15) 68 F—boiling Good
Aluminum Sulfate	10, 30%* (20) Boiling Excellent	....	....	....	10% (15) 68 F Good

NOTE: 5, 10% indicates 5% and 10%; 5–10% indicates 5% to 10%, etc.

**Complete corrosion tests currently being conducted in TAM Laboratory along with corrosion tests on acetone and stearic acid.*

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(14) *Shaw, W. E., "Corrosion of Titanium and Some of Its Alloys", Titanium Alloy Mfg. Div. Report, National Lead Co., Sept. 18, 1950, pp. 4–10.*

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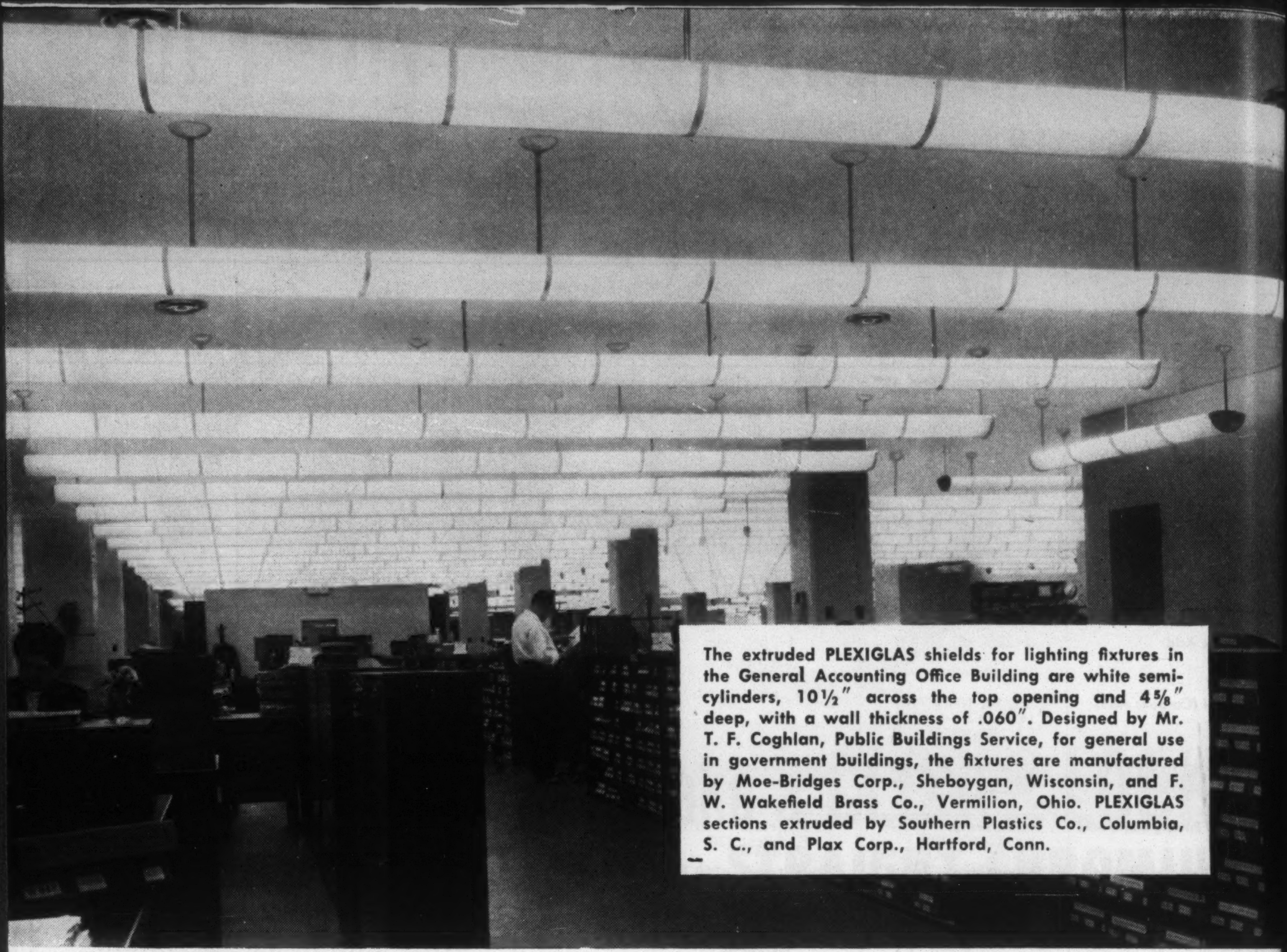
(20) *Corrosion Tests conducted in TAM Laboratory.*

(21) *Corrosion Tests conducted at Ohio State University under supervision of M. G. Fontana.*

Compiled by E. Wick, Titanium Alloy Manufacturing Div., National Lead Co.



The extruded PLEXIGLAS shields for lighting fixtures in the General Accounting Office Building are white semi-cylinders, 10½" across the top opening and 4⅝" deep, with a wall thickness of .060". Designed by Mr. T. F. Coghlan, Public Buildings Service, for general use in government buildings, the fixtures are manufactured by Moe-Bridges Corp., Sheboygan, Wisconsin, and F. W. Wakefield Brass Co., Vermilion, Ohio. PLEXIGLAS sections extruded by Southern Plastics Co., Columbia, S. C., and Plax Corp., Hartford, Conn.

25 Miles of
EXTRUDED PLEXIGLAS

At the new General Accounting Office Building in Washington, twenty-five miles of PLEXIGLAS acrylic plastic shields are used to reflect and transmit light from nearly thirty-three thousand fluorescent fixtures. Extrusion-grade PLEXIGLAS made possible the most economical production of shields that would meet the rigid requirements of the application—dimensional stability, resistance to discoloration and breakage, and control of the transmittance-reflectance ratio.

For *your* large volume applications requiring extruded parts, consider PLEXIGLAS. Extrusion-grade PLEXIGLAS molding powders are being used for a wide variety of shapes—curved panels, tubes, rods, and flat and corrugated sheets. Such sections have the familiar PLEXIGLAS properties of light weight, durability, dimensional and color stability, and resistance to age and weather.

For information on clear and colored PLEXIGLAS powders for injection and extrusion molding, write for our technical bulletins. We'll be glad to send you full details.

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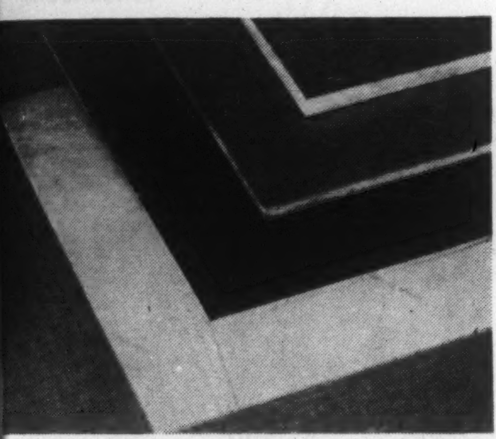
New Materials and Equipment

Plastic Sheet Finds Application in Electrical, Chemical and Appliance Fields

A medium high strength glass fiber reinforced plastic sheet has been announced by the *Dynakon Corp.*, 5509 Hough Ave., Cleveland 3.



Sheet size of this plastic available at the present time is 18 by 28 in. in thicknesses of 1/16, ⅛, 3/16, ¼, ⅜ and ½ in.

Designed to fill the demand for a sheet intermediate in strength between A3A machining and electrical grade sheet and E1B high-strength sheet, G1A is claimed to have excellent properties for stressed applications in the electrical, chemical and appliance fields It is also suitable for use in making luggage and trunks.

As is the case with other Dynakon plastics, G1A is resistant to acids, salts and mild alkalies as well as to organic solvents. Its tensile strength is 19,000 psi; compressive, 24,000 psi; impact is 15 ft lb. Among the electrical properties are dielectric strength, 325 v/mil; arc resistance, 120 sec; and power factor, 4.7. Dielectric constant is 4.40 and specific gravity is 1.49.

Decorative high-strength plastic sheeting has also been developed by the company. The material is available in sheets 1/16 and ⅛ in. thick by 18 by 28 in., in simulated leather red, green, blue, and olive drab.

These plastics have high strength and scuff resistance.

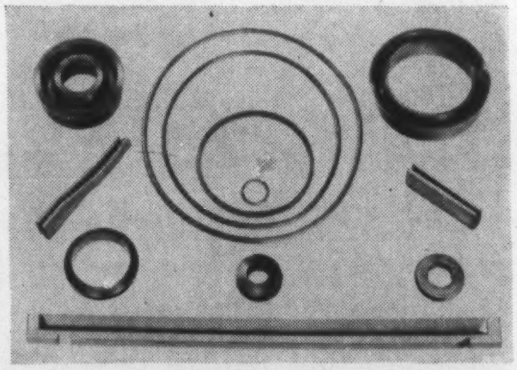
Strength and scuff resistance of the material is said to be extremely high, the strength/weight ratio being higher than that of steel. Actual density of the plastic is the same as magnesium. Dynakon A3A decorative sheet is temperature and solvent resistant to 300 F, and is recommended for use in luggage, handbags, appliances and instruments.

Rubber Compound Restrains Shrinkage and Swelling

Developed in the laboratories of the *Acushnet Process Co.*, New Bedford, Mass., a new rubber compound, X 1692, is said to restrain shrinkage and swelling, the twin problems in oil resistant applications.

A Buna N compound of 70 Shore A durometer, X 1692 has a minimum swell in low analine point oil, and a minimum shrinkage in high analine point oil.

Designed specifically to overcome extreme conditions critical to the life and efficient operation of products, the new compound is said to prevent corrosion and damage to such metals as aluminum, magnesium and other alloys or stainless steel. The company is now producing packings, bushings, seals and couplings from this stock under positive quality control methods.



These parts have been fabricated from a rubber compound which restrains swelling and shrinkage.

Stainless Steel Coating Designed for All Metal Surfaces

The Steelcote Manufacturing Co., St. Louis, has developed a new surface coating which is said to perform many tough maintenance jobs not satisfactorily performed by pigmented paints and enamels.

Applied by either brush or spray gun, the coating's color is that of unpolished stainless steel. It dries to handle in 30 to 60 min; for regular use in 3 to 4 hr.

Advantages claimed for the new coating are: protection against rust, corrosion and other types of deterioration caused by salt air and water, industrial atmospheres, alkalies, oils, greases, most strong acids, heat, cold and sunlight. Film is non-inflammable, odorless, tasteless when dry.

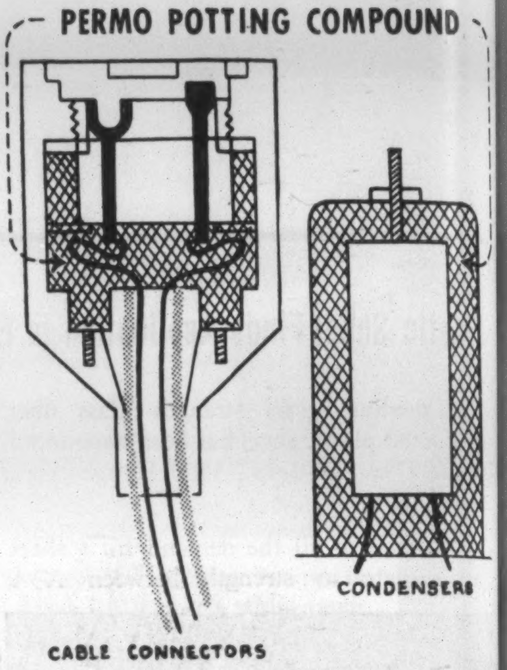
Machinery that should be made out of stainless steel but is not, due to present shortages, can now be coated with it. Defense plants, the Armed Services and the government are studying the possibilities of using the new coating for the purpose of reducing surface deterioration of machinery and equipment.

New Materials and Equipment continued

Sealing Compounds Resist High Voltage and Moisture

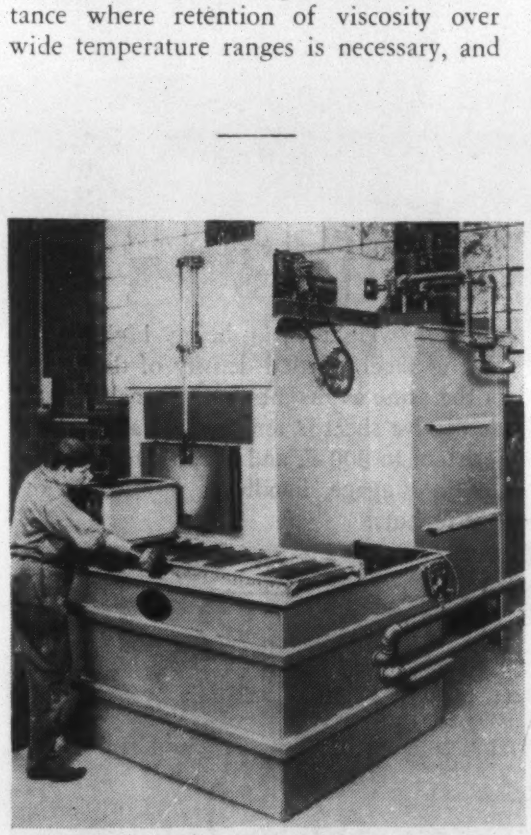
H. V. Hardman Co., Inc., 571 Cortlandt St., Belleville, N. J., has introduced a new line of sealing compounds especially designed for use where high electrical insulation and low moisture transmission are required.

Known as Permo Potting and Sealing compounds, the new products have found a wide variety of uses in such fields as electronics, where specifications are highly exacting. They are particularly recommended for special high electrical resistance where retention of viscosity over wide temperature ranges is necessary, and according to the company, they have been found ideal for the casting and sealing of electronic parts, batteries, transformers, coils, condensors and many types of electric parts.



This new line of potting compounds is designed for sealing compounds with high electrical resistance coupled with wide temperature tolerances.

Pitless, Controlled Atmosphere Furnace for Small Work



This pitless controlled atmosphere furnace covers an area approximately 6 1/3 ft wide by 12 ft long with a required head room of 14 ft.

The Dow Furnace Co., Detroit, has announced the development of a small, pitless batch-type controlled atmosphere furnace for production gas cyaniding, gas carburizing, clean hardening and carbon restoration. Called the Model G, the unit is completely mechanized and self-contained for ease of operation and simplified material handling.

In operation, the Model G is said to heat 500 lb of work from room temperature to 1500 F in 1 hr, provided the furnace is stabilized at control temperature when the load is introduced. Net loads up to a maximum of 600 lb of work can be processed, although the net loads will naturally vary with the type of parts, temperatures and case depths.

Uniform rapid heating of the new furnace is accomplished by four radiant tubes fired with standard Dow burners piped to necessary control valves. A gas generator system of catalytic type is incorporated within the radiant tubes to supply a gas neutral to medium carbon steels.

An unusual feature of the tube and generator system is that the generator gas can be analyzed before going into the furnace. A high volume fan combined with a fan inlet assures a directed flow of atmosphere through the furnace load, producing uniform heating and case depths. Quenching is done directly from the furnace vestibule, and the oil in the quench tank is circulated in a similar manner to that of the atmosphere.

New Finish for Use with Fiber Glass Reinforced Plastics

A stronger, more waterproof bonding in fiber glass reinforced plastics is said to be afforded by a new chemical finishing treatment developed by *Owens-Corning Fiberglas Corp.,* Toledo 1, Ohio.

The finish, No. 136, is applied to Fiberglas fabric when this material is used to reinforce polyester resin in molded laminates. Officials of the company explained that plastic parts, such as those used in military aircraft, can now lose from 1/3 to ½ of their strength after prolonged immersion in water. Use of the new finish reduces loss of strength to less than 10%.

Company tests show that molded laminates made with glass cloth treated with finish No. 136 possess flexural strengths above 60,000 psi after soaking in water for 30 days. Since polyesters tend to absorb moisture from the air, the finish gives added strength whether or not the laminate is actually subject to prolonged immersion in water.

According to the company, use of the new finish will enable fabricators of polyester molds reinforced with Fiberglas cloth to extend uses for parts for airplanes, amphibious vehicles, military and pleasure boats, corrosion resistant pipe, and many other items. Its use is also expected to result in the upgrading of specifications established by the military services for performance of fiber glass plastic items.

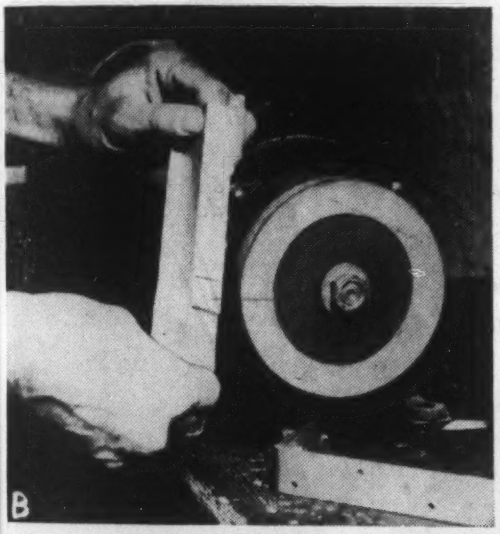
Heat Resistant Aluminum Paint Permits Quick Air Drying

Improvement in its Heat-Rem H-170 extra high heat resistant aluminum paint to permit air drying in approximately 30 min has been announced by *Speco, Inc.*, 7308 Associate Ave., Cleveland 9.

This new paint is said to mark a radical departure from ordinary high heat paints which usually must be baked on and will not air dry. H-170 is capable of withstanding temperatures up to 1700 F. It utilizes a silicone base and is said to fuse with the surface metal. It forms a bright, elastic finish resistant to moisture, corrosion, mild acids, alkalies and industrial fumes.

Recommended for use on heat lines, condensors, compressors, ovens, engine heads, mufflers, radiators and exhaust manifolds, the new paint is said to make possible the effective painting of many types of industrial equipment previously regarded as unpaintable because of temperature limitations. H-170 is intended for use as a companion product to standard Heat-Rem, which is adapted to applications in the temperature range of 1000 to 1500 F.

Rubber-Cushioned Abrasives Finding Wide Application



Here a stainless steel part is being polished with the new rubber-cushioned abrasive.

A new product which utilizes the cleaning-polishing action of rubber and the finishing action of abrasives in combination, has been developed by Brightboy Industrial Div., *Weldon Roberts Rubber Co.*, Newark 7.

The action of abrasive and rubber Brightboy is said to be unique in that the rubber gently retards or cushions the cutting effect of the abrasive. The cleaning and polishing properties of the rubber binder are obvious.

Rubber-cushioned abrasives are made for both machine and manual use, in wheels, sticks, rods and blocks. Surfacing is controlled by pressure and/or the speed of the abrasive against the object being finished. Both conventional and special surface effects—damaskeening, for example—can be achieved. The new type abrasives can also be used for close tolerance, precision work, and can be shaped to curved or contoured surfaces. Most times it will burr, finish, clean, polish in one operation.

In addition to its wide applications in finishing products, parts and assemblies, Brightboy is used to finish and maintain basic tools, dies, molds, jigs, patterns, machines and parts. Special uses already proved in defense manufacture include adaptation in the production of internal combustion and jet engines, airplane parts, electrical and electronic equipment and many types of instruments.

Fabric Tubing Offers Good Abrasion and Chemical Resistance

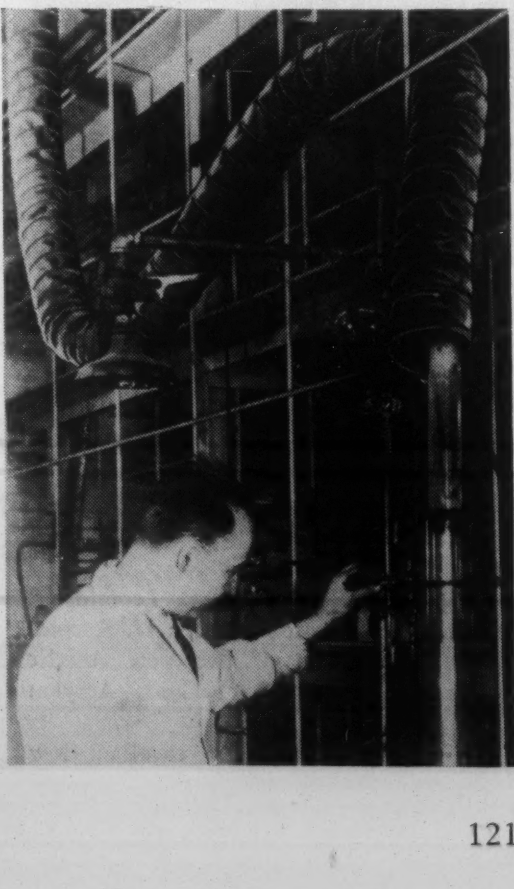
A new, flexible fabric tubing for ventilation and product handling is currently being offered by *Flexible Tubing Corp.*, Guilford, Conn. Spiratube is offered with vinyl plastic coating, which is said to give good abrasion resistance for rough handling and inertness to chemicals and oils.

The tubing's light weight and accordion-like retractability make handling or shipping easy. It is non-kinkable and will not collapse under average fan suction pressures.

The basic patented construction principle consists of preformed, continuous, spring wire ribbing, which is overlapped with spirally wound woven fabric of several alternate types. After fabrication the tubing is coated with a Geon latex, product of B. F. Goodrich Chemical Co., providing the abrasion and chemical resistance.

Designed initially as ventilation tubing for the U. S. Navy, the product is said to be easily adapted to the conducting of air and other gases, many solids and liquids at low pressure, all under a variety of service conditions.

Connecting or coupling sections of tubing together is done easily and tightly with an exclusive Flexible belt clamp. Optimum flexibility make elbows and other fittings unnecessary.



This tubing's light weight and accordion-like retractability make handling or shipping easy.

New Materials and Equipment continued

Fiber Glass Plastic Offers Many New Possibilities

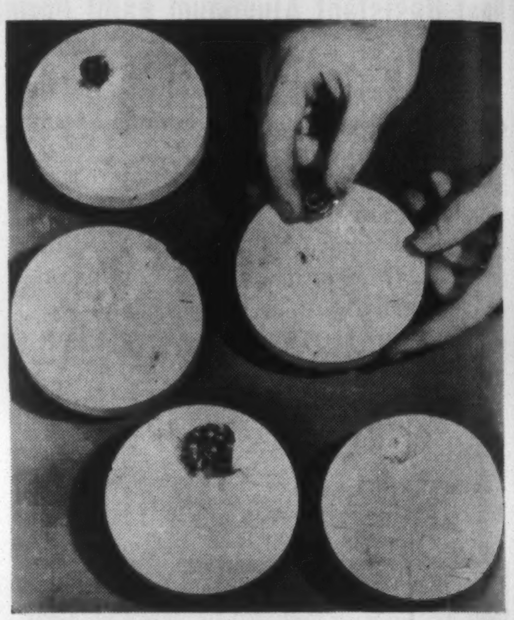
Expanded military and civilian uses for high strength plastics are forecast in an announcement of a new plastic molding material by the *Plaskon Div., Libbey-Owens-Ford Glass Co.,* Toledo, Ohio.

The new material is a fiber glass and plastic resin combination designated as Plaskon Reinforced Alkyd molding compound which joins three other alkyd plastics in the Plaskon line, although it is the first of this group to utilize fiber glass as a reinforcing material. The plastic is said to have higher impact strength than any other plastic material, and it can be molded at high production rates by conventional plastic molding methods.

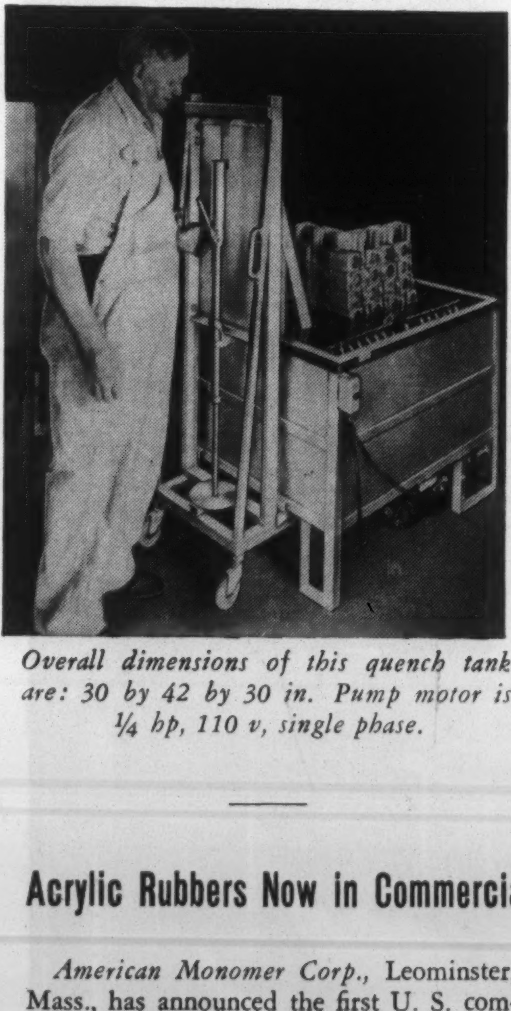
According to the company, the new material is being evaluated by various military departments, and its eventual use in such civilian products as refrigerators, washing machines, electrical switchgear and electronic devices of many kinds is anticipated. At the present time the fields of use for the material are largely unexplored, but they appear to be those applications where high impact strength, high heat resistance, extreme dimensional stability and good electrical properties are required.

Since the middle of World War II glass fibers have been used in conjunction with plastic resins to make high-strength, shock-resistant parts such as radar and photographic housings, body armor, structural aircraft components, and a limited number of civilian uses. The new product is said to combine the good physical properties of these glass-fiber laminates with the fast, labor-saving production methods possible with alkyd and other plastic molding compounds.

The compound is supplied to molders as a complete resin and glass fiber mixture. It can be preformed if desired, but no preheating is necessary because of its fast curing properties. Reinforced Alkyd can be either straight compression, or transfer molded. It will be sold in two forms: Plaskon Alkyds 440 and 442—the latter having particularly good flame resistance.



Disks of the new fiber glass plastic received hits from a Colt .45 at distances of 30 and 50 ft. Bullets were flattened while plastic remained strongly intact, though chipped.



New Type Quench Tank Maintains Constant Level

A new type quench tank of the constant level, re-circulating type has been introduced by *A. D. Alpine, Inc.,* 11837 Teale St., Culver City, Calif.

Designed to receive work from a mechanical loader which removes the entire load from the furnace and quenches it in one easy operation, this Contro-Therm quench tank cools as it circulates the quenching liquid. Moreover, an airflow circulator can be added to make it usable with more than one furnace.

In addition to the main quench tank, this single piece of equipment includes a reserve and cooling tank, pump and motor. Legs of the tank are high enough to allow a loader to slip under it so that the load can be deposited mechanically in the quenching liquid.

According to the company, the tank maintains a constant level regardless of the displacement caused by treated work; as the load is lowered into the tank, the overflow runs over a low dividing wall into the reserve section of the tank. In this section, a heavy-duty pump constantly circulates the liquid back into the main part of the tank, aerating and cooling the liquid to insure a uniform quench. Directional flow can be changed at will.

Acrylic Rubbers Now in Commercial Production

American Monomer Corp., Leominster, Mass., has announced the first U. S. commercial production of two new Acrylic rubbers—Acrylon BA-12 and Acrylon EA-5.

BA-12 is said to show excellent low temperature characteristics and resistance to heat, hot oils, boiling water, oxygen, ozone and sunlight. Acrylon EA-5 has somewhat less low-temperature flexibility but increased oil resistance. Both rubbers are claimed to be unexcelled for resistance to flex cracking.

The new rubbers were pioneered as Lactoprene rubbers by the Eastern Regional Research Laboratory of the U. S. Dept. of Agriculture.

(More News on page 124)

ALUMINUM PERMANENT MOLD CASTINGS

also sand-cored and heat-treated

HIGH PRESSURE ALUMINUM DIE CASTINGS

machined, finished, assembled

CERTIFIED ZINC DIE CASTINGS

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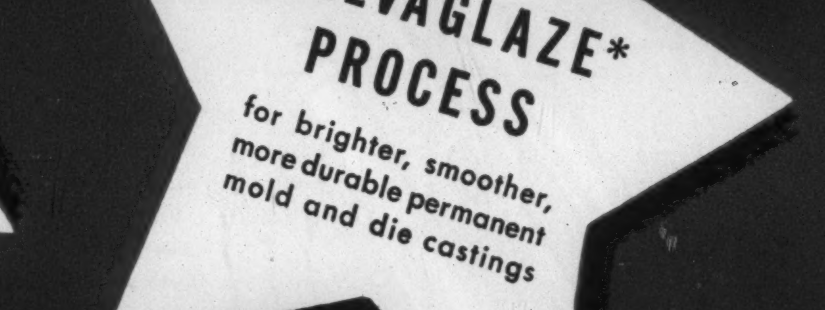
WRITE TODAY for your copy of our new "FACT-FILE" folder which illustrates and describes Monarch's outstanding facilities. You'll want it for your castings source file.



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Automobile manufacturers too, know "Standard" welded tubing safely stands the severest tubular applications. This is proven in the automobile propeller shaft that operates safely and dependably at high R.P.M.'s day in and day out.

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Welded Tubing
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STANDARDIZE with "STANDARD"—It Pays

CARBON STEEL TUBING
½" O.D. to 5½" O.D.
.028 to .260 wall

STAINLESS STEEL TUBING
⅜" O.D. to 3" O.D.
.028 to .095 wall

New Materials and Equipment

Metallic Acetates Available in Lighter Weights

Metallized acetates are currently being introduced in lighter weights as a result of the development of a 100-gage metallized material (0.001-in. thickness) in a range of eight colors, according to a recent announcement from *Coating Products,* 136 W 21 St., New York.

The addition of the lighter weight to the company's present line of gages, 0.003 to 0.020, is said to offer converters many new possibilities, particularly in the replacement of foil papers, which are becoming increasingly difficult to obtain. While the 0.001-in. thickness can be used for many purposes in sheeting form because of its flexibility and pliability, it can also be laminated to paper and board, thus providing even more glittering effects than foils plus affording the additional advantage of a protective surface.

Colors include silver, gold, royal blue, red, chartreuse, green, pink and orchid. The new product is produced in 20-in. widths in rolls up to 2000 ft in length or sheeted to specifications.

Strain Tester Features Simple, Positive Additive Weight Loading

Scott Testers, Inc., Providence, has announced a new strain tester which performs elongation tests on rubber and other high elastomers in accordance with methods developed by the National Bureau of Standards. The instrument was initially developed by the Bureau of Standards, and subsequently modified by the company.

The test performed by this instrument is the standard test for determination of strain, expressed as a percentage of the original sample gage length under known and constant unit stress. Sample of uniform width and length are die-cut from the sheet of material to be tested. Upon the sample is superimposed a gage length of 10 cm by means of visible markings. The sample is then stressed by loading with fixed additive weights to produce unit values of 50, 100, 200 or 400 psi. Thus loaded, the sample is suspended in a free static condition for a sufficient period of time to permit satisfactory dimensional stability to be reached. At the conclusion of the test interval, the elongation of the sample is measured and compared with the original gage length.

An outstanding advantage of the tester is its unique method of additive weight

Overcome Steel Shortage Reduce Costs

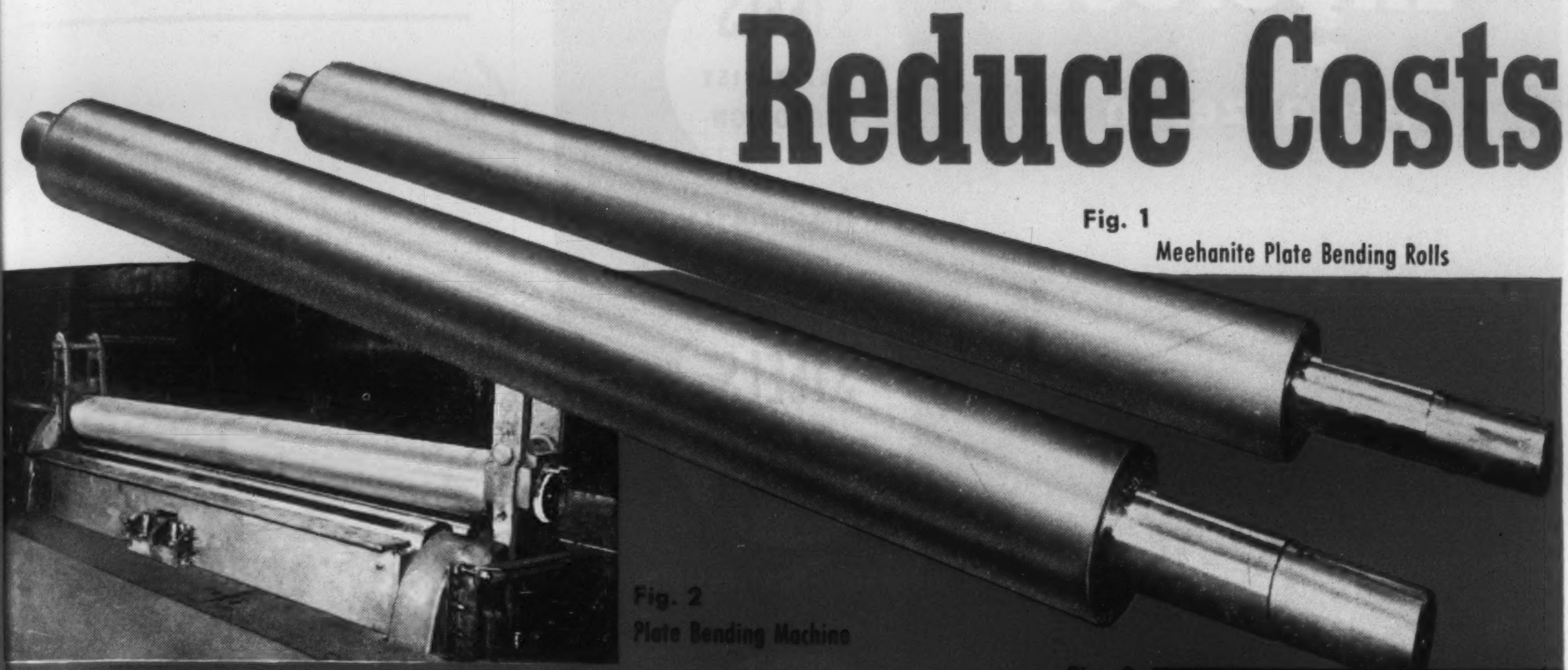
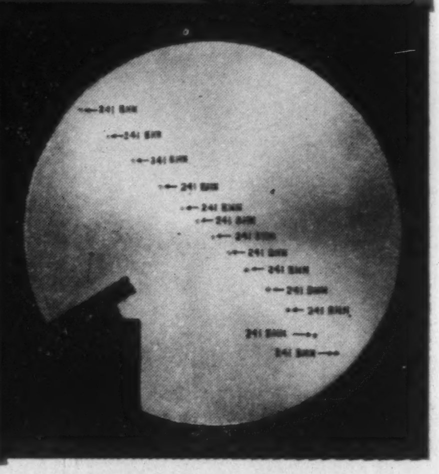


Fig. 1
Meehanite Plate Bending Rolls

Fig. 2
Plate Bending Machine

Fig. 3
Uniformity proved
by Brinell Readings



SPECIFY MEEHANITE CASTINGS

he two Meehanite rolls shown, Fig. 1, have replaced forged olls in a pyramid plate bending unit, Fig. 2. This is believed o be the first such installation.

Overall length of each roll is 14½ ft., diameter 13 inches. he rolls handle plate thicknesses up to 1¼ inches and 48 nches wide, imposing extremely unusual stresses on the jour-nals and requiring high resistance to fatigue. They have been n daily service for over 18 months providing the toughness, trength and rigidity needed for this application.

Hardness and tensile tests were made from a 15″ diameter iser used in pouring the casting, Fig. 3. Reading—241 Brinell cross *entire* diameter; Tensile Strength 47,000 psi.

SAVED { STEEL FORGINGS *(always used previously)*
6000 DOLLARS *(time—material).*

For information about how Meehanite Castings can improve our product, write—

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New Rochelle, N. Y.

Take *Your* Casting Problem To A

MEEHANITE FOUNDRY

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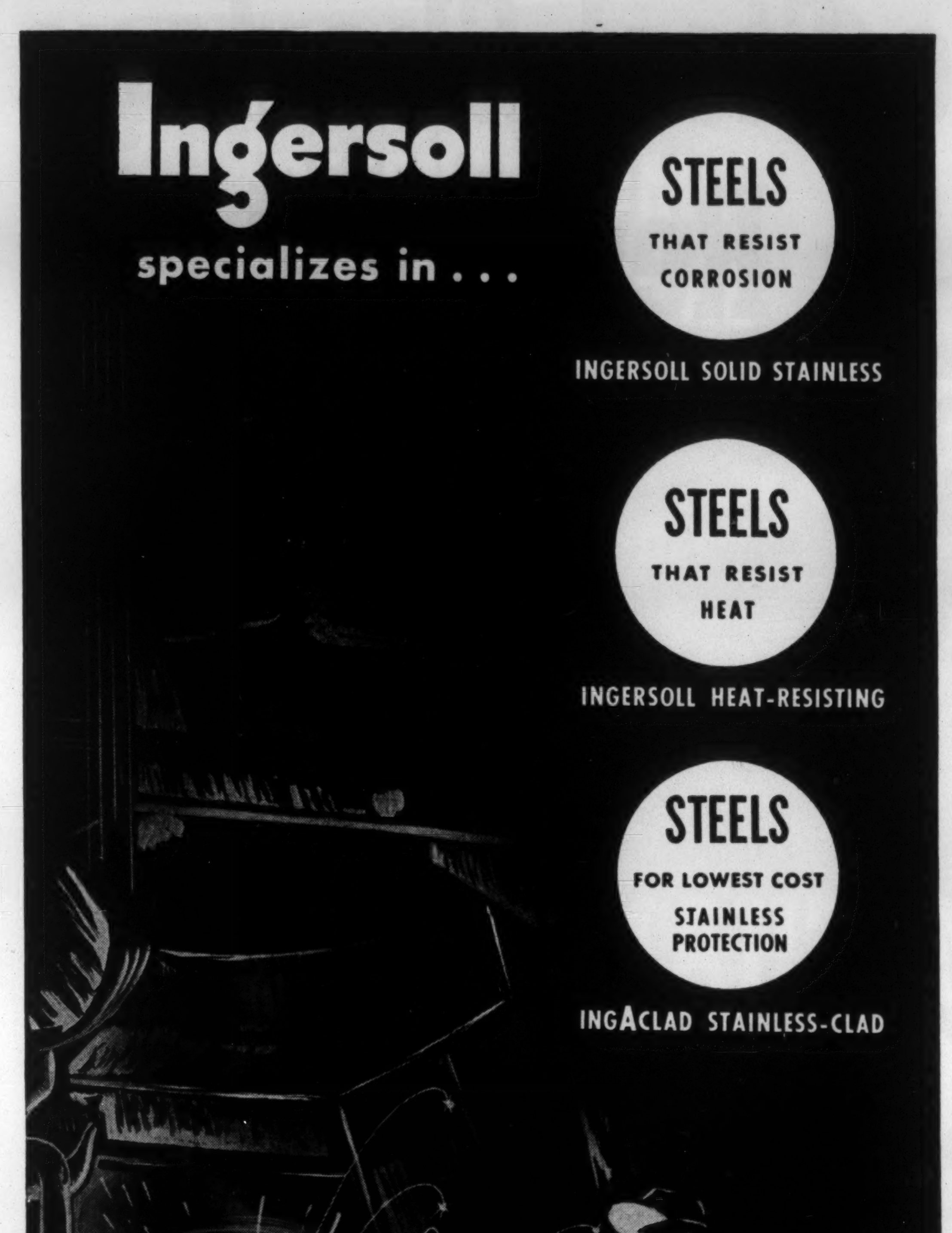
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."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STEELS
THAT RESIST
CORROSION

INGERSOLL SOLID STAINLESS

STEELS
THAT RESIST
HEAT

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STEELS
FOR LOWEST COST
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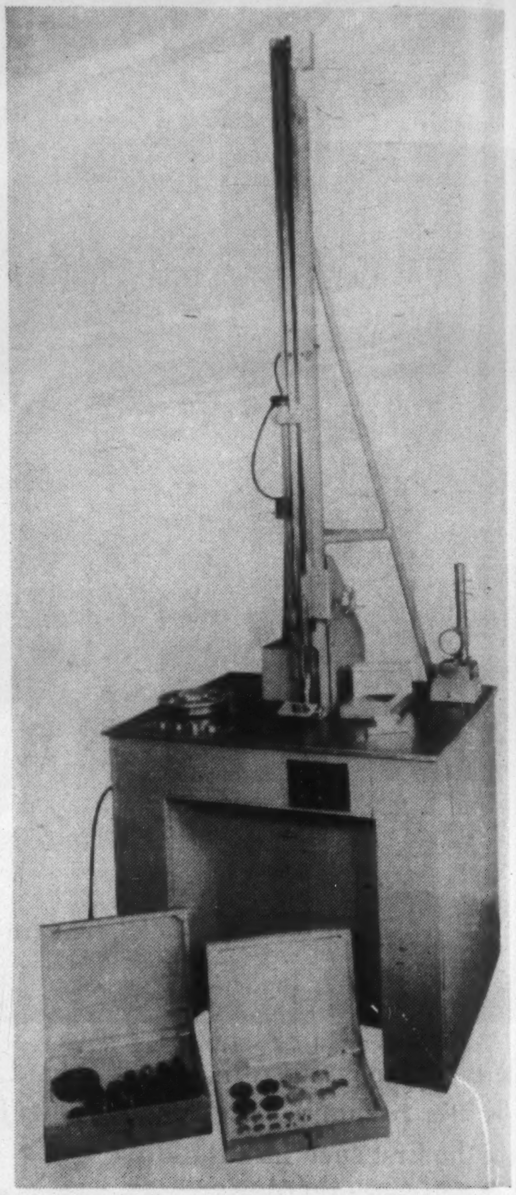
Ingersoll STEEL DIVISION
BORG-WARNER CORPORATION
310 South Michigan Avenue, Chicago 4, Illinois
Plant: New Castle, Indiana

New Materials and Equipment



The test performed by this unit is the standard test for determination of strain, expressed as a percentage of the original sample gage length under known and constant unit stress.

loading, which is simple and positive. Selection of the additive weights is accomplished mechanically, without the use of electrical circuits, which are subject to mal-functioning under the climatic conditions in rubber producing areas. Another feature of the unit is that it is so designed that all controls and observations are available to the operator while comfortably seated. For convenience, all electrical equipment is localized so that only a single source of current is required.

Lacquer and Enamel Have High Corrosion Resistance

A new porcelain-like enamel, designed to withstand the rigors of outdoor life, and which is said to provide long-lasting resistance to the weather and abrasion, has been developed by *United Lacquer Manu-*

FREE. Send for illustrated 20-page mainspring guide to better product design and performance . . .

Sandsteel Spring Division—Sandvik Steel, Inc.
145 Hudson Street, New York 13, N. Y.

Gentlemen: Kindly send, without obligation, a copy of "Sandsteel Springs for Dual Power."

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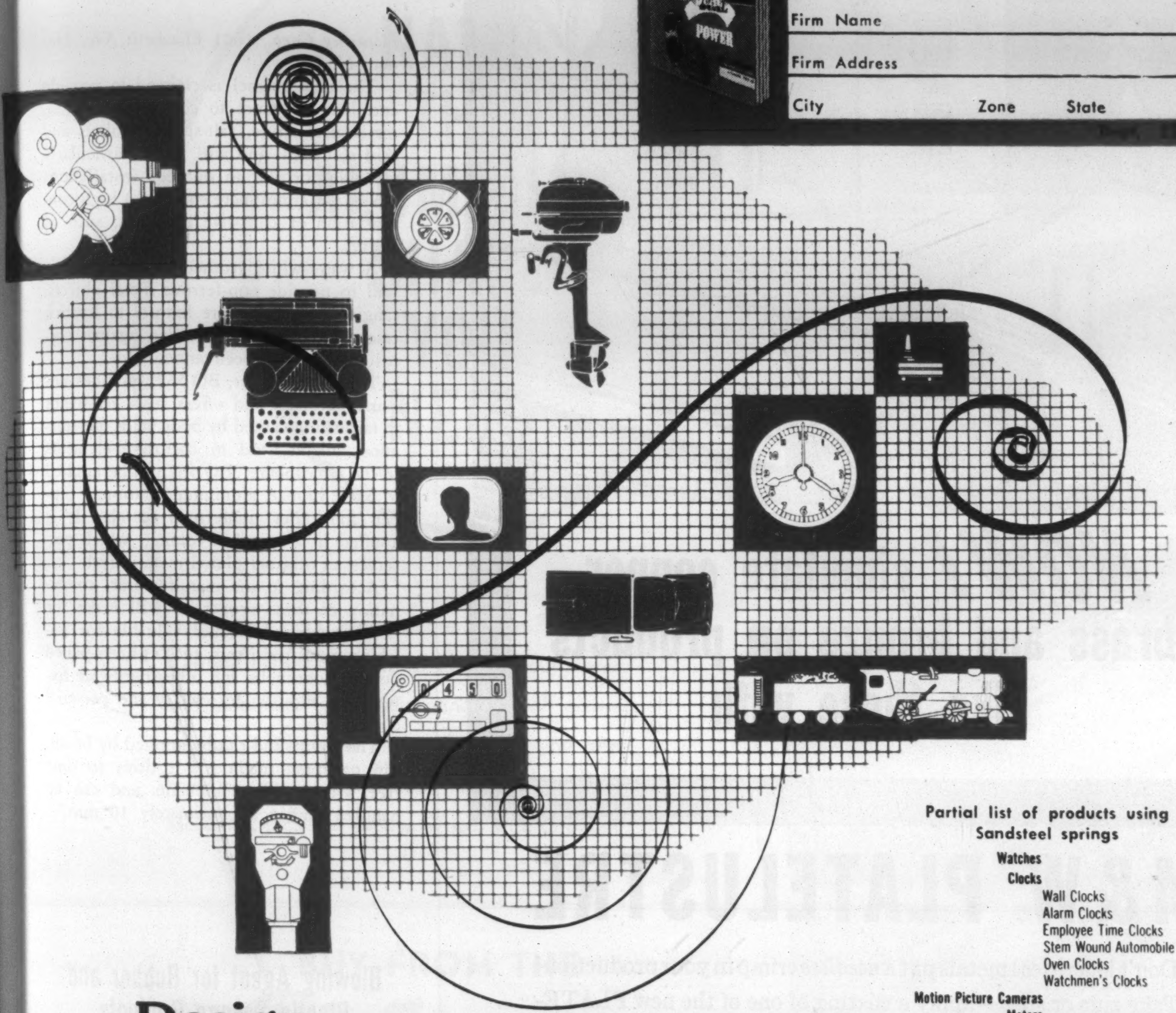

Partial list of products using Sandsteel springs

- Watches
- Clocks
  - Wall Clocks
  - Alarm Clocks
  - Employee Time Clocks
  - Stem Wound Automobile Clocks
  - Oven Clocks
  - Watchmen's Clocks
- Motion Picture Cameras
- Motors
  - Outboard
  - Portable Saw
  - Power Lawn Mowers
- Office Machines
  - Calculators
  - Computers
  - Comptometers
  - Typewriters
- Timing Devices
  - Parking Meters
  - Switches for Washing Machines
  - Electric Time Switches
- Instruments
  - Tachometers
  - Altimeters
  - Gauges
  - Electric Meters
- Recording Devices
- Earphones
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- Television Aerials
- Vending Machines
- Reels (return mechanism)
- Toys

Design DUAL POWER into your product

DO YOU HAVE A PRODUCT THAT REQUIRES A FLAT SPRING? For superior design and performance of that product, inquire about Sandsteel CROSSCURVED Mainsprings. The crosscurving allows use of longer, thinner springs, giving more flexibility of design and a far more even delivery of energy. Take advantage of a quarter century of Sandsteel mainspring know-how, and consult us regarding your spring requirements. Write for informative brochure . . . without obligation.

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NOW! simulate copper, brass and bronze on products like these with

M & W PLATELUSTRE

Don't let critical metals put a *needless* crimp in your production!

Take zinc or steel—apply a coating of one of the new PLATELUSTRE finishes. You wind up with products and parts that look so much like copper, brass and bronze that *the eye can scarcely tell the difference!*

Whether you have been using now unavailable copper and its alloys for *making* products or for *plating* products, you will find these new M & W finishes *equally* effective in keeping your plant running. There are types for air-drying and baking schedules — pick the one that best fits *your* production requirements.

Let an M & W Technical Service Engineer show you—*right in your own plant*—how easy these PLATELUSTRE coatings are to use, and what striking effects they produce. Or, if you prefer, write for free literature.

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OUR 76th YEAR • M & W CO. 1870

MAAS & WALDSTEIN CO. 438 RIVERSIDE AVE. NEWARK 4, N. J.

Midwest Div.: 1658 Carroll Ave., Chicago 12, Ill. • Pacific Coast Div.: Smith-Davis Co., 10751 Venice Blvd., Los Angeles 34, Cal.

MANUFACTURERS OF INDUSTRIAL FINISHES

facturing Corp., 1001 Elizabeth Ave, Linden, N. J.

The new enamel is claimed to provide excellent resistance to chipping, abrasion, mechanical abuse, salt-spray, alcohols and acid solutions, and will prove particularly valuable for use in outdoor installations where the atmosphere contains a high concentration of corrosive materials, such as sulfur.

A water-white synthetic lacquer that is said to provide non-ferrous metal objects, ranging from hardware fixtures to lipstick cases, with lasting protection against corrosion, has also been announced.

The clear lacquer, BO 562, provides unusual hardness and offers high resistance to tarnishing caused by body acids, perspiration, alkalis, and to corrosive elements in the atmosphere. BO 562 can be applied to brass, bronze, aluminum, platinum, copper and other nonferrous metals. It is applied in a hair-thin coating, which preserves an original plated metal effect.

According to the manufacturer, combination of these properties will make the new resin-based lacquer valuable for finishing industrial items, such as brass-plated domes, doorknobs and other hardware fixtures, in addition to jewelry and personal objects.

The compound can be applied by brush, dip or spray methods. It dries to dust free within a few moments and can be handled within approximately 10 min.

Blowing Agent for Rubber and Plastic Sponge Products

A new chemical blowing agent for the manufacture of both rubber and plastic sponge products has been developed by the *Naugatuck Chemical Div., U. S. Rubber Co.*, Rockefeller Center, New York 20.

Chemically, the blowing agent is p,p'-oxybis (benzene sulfonyl hydrazide). It is a stable white powder at normal temperatures but decomposes at temperatures above 135 C with the liberation of nitrogen gas. Because of its high decomposition point, it can be added to relatively hot stocks on a mill without danger of a premature blow.

The agent can be used with either natural or synthetic rubber, a variety of plastics and the new rubber-plastic blends. Sponge rubber made with the chemical has a fine uniform cell structure of either the open pore or closed pore type. The sponge can be non-staining, non-discoloring and odorless.

According to the manufacturer, the blowing agent is particularly suited for the

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YOU
NEED

Here's a good, dependable source for aluminum extrusions in quantity. Send us your inquiry with adequate information and we will answer promptly. Whatever aluminum shape you need for your product or contract, Youngstown Manufacturing, Inc., can supply. Write, wire or phone.

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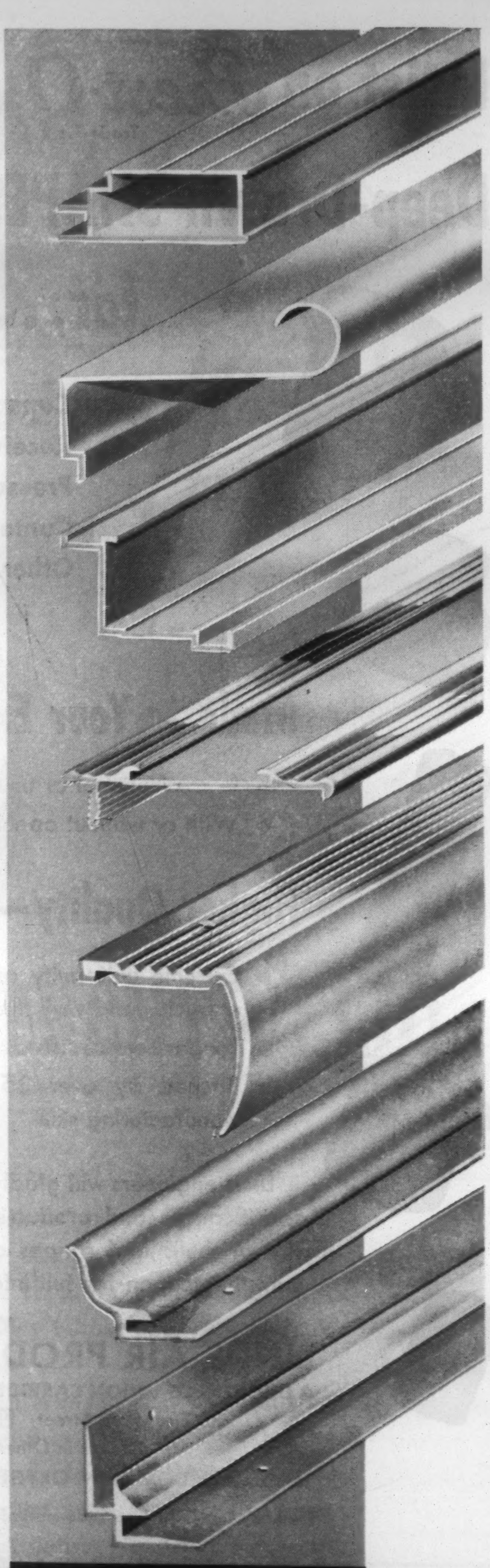

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SUPERIOR
ALUMINUM
EXTRUSIONS

Insist on *Prest-O-Lite*
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Deep-Drawn SHAPES and SHELLS for...

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Made to Your Exact Specifications

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- Extreme uniformity of size, weight, strength, capacity and wall thickness
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LINDE engineers will gladly help you with your designs, specifications and production problems involving cold-drawn shells and shapes or formed metal parts. Just mail the coupon for full information.

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Offices in Other Principal Cities
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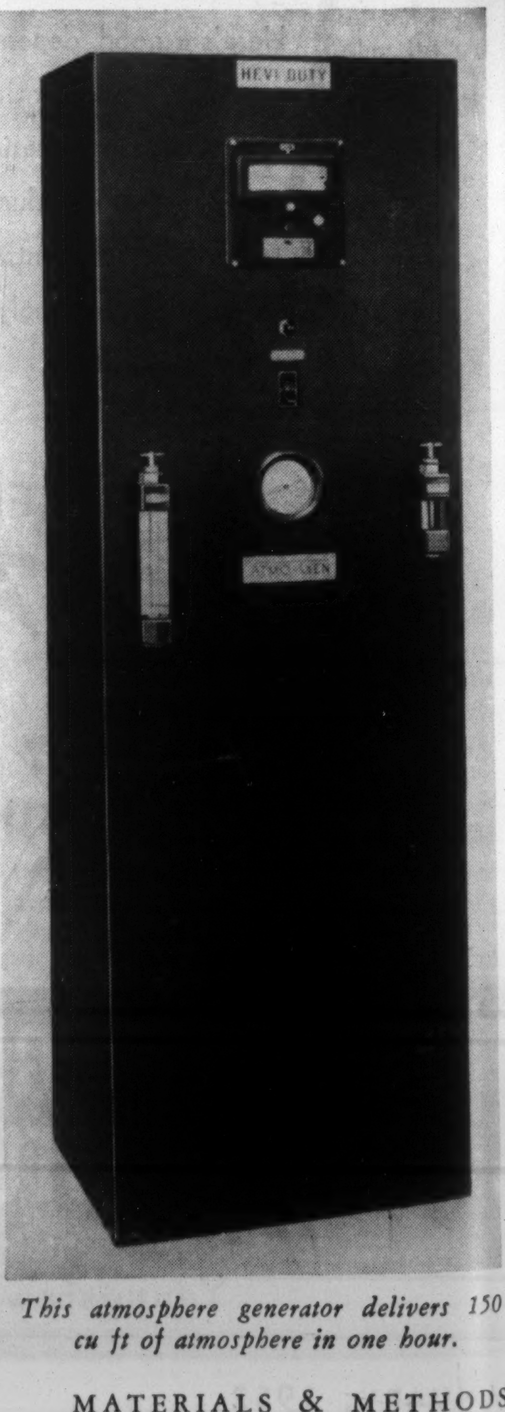
manufacture of vinyl plastic sponge. The resulting vinyl sponge is unusually buoyant, weighs 6 to 8 lb per cu ft, is flame-proof, and ranges from a rigid to a soft structure. Tests to date indicate it to be nontoxic, a feature which makes it possible to be used in various medical application.

Some of the end product applications in which the agent is expected to be used are: shock pads; aircraft wing lining; rug underlay; fishing floats; mine cable floats; life rafts; life rings and cushioning materials.

Atmosphere Generator for Various Heat Treating Operations

A new type atmosphere generator has been announced by *Hevi Duty Electric Co.*, Milwaukee 1.

Used to provide atmospheres for such heat treating operations as clean non-de-



This atmosphere generator delivers 150 cu ft of atmosphere in one hour.

wherever you need stainless steel tubing...

TRY TRENTWELD!

● Stock lines in food, paper, and chemical plants; heat exchanger units in processing industries; cooling coils in breweries, beverage industry, dairies and dairy equipment... throughout all industry, wherever there's a stainless or high alloy tubing application, there you'll find TRENTWELD.

And it's to be expected! TRENTWELD is made in a tube mill by tube engineers who roll and weld stainless and high alloy tubing exclusively. Then too, TRENTWELD is available in a full range of sizes – 1/8″ to 36″ in diameter. This, coupled with Trent's convenient mid-continent location, means prompt delivery of what you want ...when you want it. If yours is a stainless or high alloy tubing requirement: Call on us.

TRENTWELD

STAINLESS STEEL TUBING

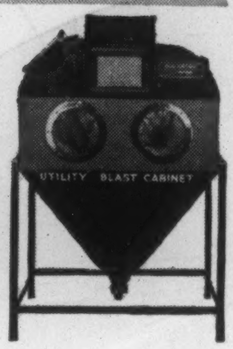
TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN

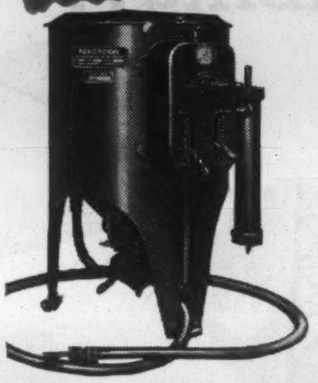
(Subsidiary of Crucible Steel Company of America)

Here's how Pangborn
Solves these Problems
with this modern equipment

BLAST CLEANING!

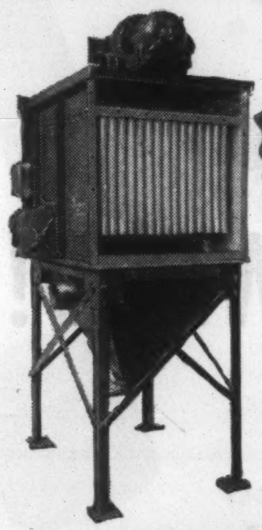
Blast Cleaning Cabinet quickly and easily cleans rust, grime, dirt, paint, etc., from metal parts. Produces a clean, smooth surface on pieces up to 60″ x 36″. Models available from $315.00 and up.





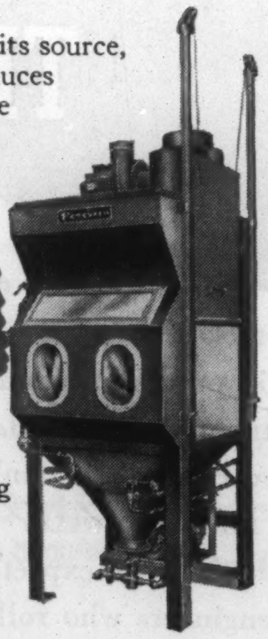
Blast Cleaning Machine not only removes rust, dirt, scale, etc., but is ideal for maintenance and many other uses. Cleans large objects such as bridges, structural work, tanks before painting. Six sizes, portable or stationary, from $170.00 and up.

DUST COLLECTING!



Unit Dust Collector stops dust at its source, minimizes machine wear and tear, reduces housekeeping and general maintenance costs. Solves many grinding and polishing nuisances. Reduces material losses. Models from $286.00 and up.

PRECISION FINISHING!



Hydro-Finish Cabinet uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001″. Models from $1295.00 and up.

LOOK TO PANGBORN FOR THE LATEST DEVELOPMENTS IN BLAST CLEANING AND DUST CONTROL EQUIPMENT

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☐ Blast Cleaning Cabinets
☐ Blast Cleaning Machines
☐ Unit Dust Collectors
☐ Hydro-Finish Cabinets

PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me more information on the equipment I've checked at the left.

Name..
Company..
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carburized hardening, dry cyaniding or carbonitriding, carburizing (carrier gas), copper and silver brazing, nitriding, sintering and bright annealing, the unit delivers 150 cu ft of atmosphere per hour.

The Atmo-Gen consists of an ammonia cracker which is housed in a fabricated steel cabinet, an electric tube type furnace with automatic temperature control, catalyst-filled alloy retort and necessary piping and flow regulation accessories.

Steel Treating and Carburizing Compounds

The Industrial Chemicals Div., *American Cyanamid Co.,* 30 Rockefeller Plaza, New York 20, has announced the development of a new addition agent—Aerobrite—for use in preparatory treatment of steel for cold drawing, porcelain enameling and tin plating. The addition of recommended quantities of the new agent to acid pickling baths used in preparatory treatment of steel to be cold-drawn, and in similar pretreatment of steel sheets to be porcelain enameled, is said to provide many advantages.

Addition of a small percentage of Aerobrite to the sulfuric acid pickling bath used for preparation of bars and flats to be cold drawn results in the following advantages, according to the manufacturer: A uniformly clean steel surface is provided which, when coated with lime for cold drawing, produces a uniformly brighter cold finished product; removal of iron salts from the surfaces of bars and flats increases the life of the expensive dies; improvement in resistance to rusting on storage has resulted. This application merely involves the addition of ½ to 1% of the agent to the pickling bath, based on the weight of sulfuric acid present. It is important, however, that Aerobrite additions be made to the pickling bath and not to the concentrated acid previous to the make up of the bath.

In the preparation of steel sheets to be porcelain enameled, the recommended usage of the agent is on a direct pound for pound replacement for the sodium cyanide. Here, the following advantages are said to be realized: Handling and storage of highly toxic sodium cyanide is eliminated; the problem of disposal of waste sodium cyanide liquors is eliminated; Aerobrite is readily available in minimum 100-lb bags at a lower cost than sodium cyanide.

Two carburizing compounds for use as a liquid bath system combining ease of cleaning with high penetration rates have also been announced by the company. Aerocarb E is a granular mixture used for the initial fusion and for high drag-out nent

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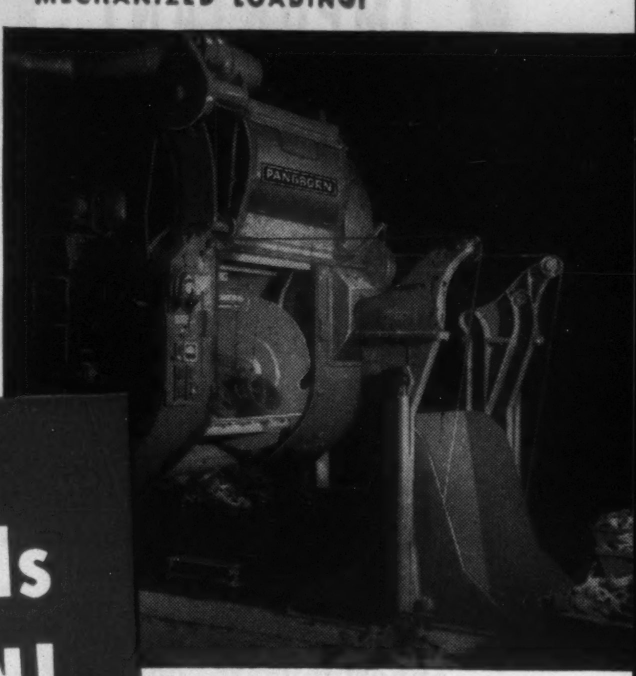
MECHANIZED LOADING!



SIMPLIFIED UNLOADING!

ere's How Pangborn ROTOBLAST* Barrels SPEED DEFENSE PRODUCTION!

SPEED is essential to defense production . . . and in case after case, Pangborn ROTOBLAST Barrels have proved they can clean castings up to 24 times faster than conventional equipment. Even loading is fast! With Pangborn automatic loading equipment, any size ROTOBLAST Barrel (from 3½ to 28 cubic feet) can be loaded *in one minute or less!*

What's more, Pangborn ROTOBLAST Barrels assure high-quality cleaning. The exclusive "rocking" action of the Barrel exposes all surfaces to the blast stream . . . makes sure pockets of intricate pieces are completely cleaned. And ROTOBLAST Barrels cost less to operate. Horsepower requirements average 87% less, smaller crews are needed and automatic abrasive recovery assures maximum economy.

FOR FASTER BLAST CLEANING install Pangborn ROTOBLAST Barrels in your cleaning room. Bulletin 213 gives you full details, specifications and actual performance as reported by users. Write today to: PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment.

These action photographs prove Pangborn ROTOBLAST Barrels are *easy to operate*. This 14' ROTOBLAST Barrel is shown in use at the Frick Company. It speeds cleaning by replacing four old-style machines and a secondary pickling operation. And with this machine two men can clean half the entire foundry's output—at an annual saving of $2540.00 on labor!

ROTOBLAST . . .

SAVES LABOR with push-button operation

SAVES SPACE because machines are compact

SAVES TIME by cleaning more loads per day

SAVES POWER since no compressor is needed

SAVES TOOLS because all scale is removed

Pangborn

BLAST CLEANS CHEAPER

with the right equipment for every job

mechanical engineers

KEY POSITIONS IN AN IMPORTANT NEW FIELD AT SYLVANIA

A leading name in the electronics industry for over 50 years, Sylvania now expands its research and development in new fields. This is a genuine opportunity to do creative thinking and pioneering research on stimulating, original projects.

MUST HAVE B.S. IN MECHANICAL ENGINEERING AND EXPERIENCE IN: EQUIPMENT COMPONENT DESIGN, AUTOMATIC EQUIPMENT DESIGN, HIGH VACUUM DESIGN, MACHINE TOOL AND METAL STAMPING DESIGN.

Liberal employee benefits. Relocation allowance.

Please forward complete resume, including details of education and experience to:

SYLVANIA ELECTRIC

Manager of Personnel
Dept. 100-B
40-22 Lawrence St.
Flushing, N. Y.

New Materials and Equipment

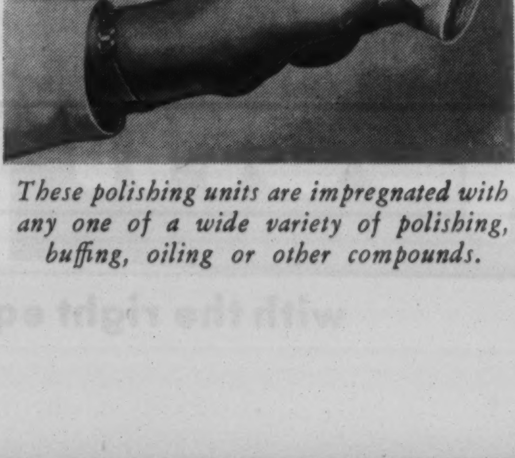
applications, while Aerocarb W is a briquetted mixture, each briquette weighing approximately 1 oz, higher in sodium cyanide content, and used to control the cyanide content of the bath in low drag-out applications.

The new compounds are said to provide an economical, dependable and convenient method for the production of case depths to 0.100 in., combining high penetration rate and ease of cleaning with the advantages inherent in the salt bath method. The two materials are balanced for use together where the optimum results characteristic of close chemical control are desired. Such a system can be used equally well for light case, high drag-out work and long-cycle deep casing applications. All grades of carburizing steel are said to be treated with equal effectiveness, differences in case depth being caused only by alloy content and the other factors which affect carbon solution and diffusion. This bath provides the high penetration rates and high surface carbon hitherto available only in baths containing calcium or barium catalysts.

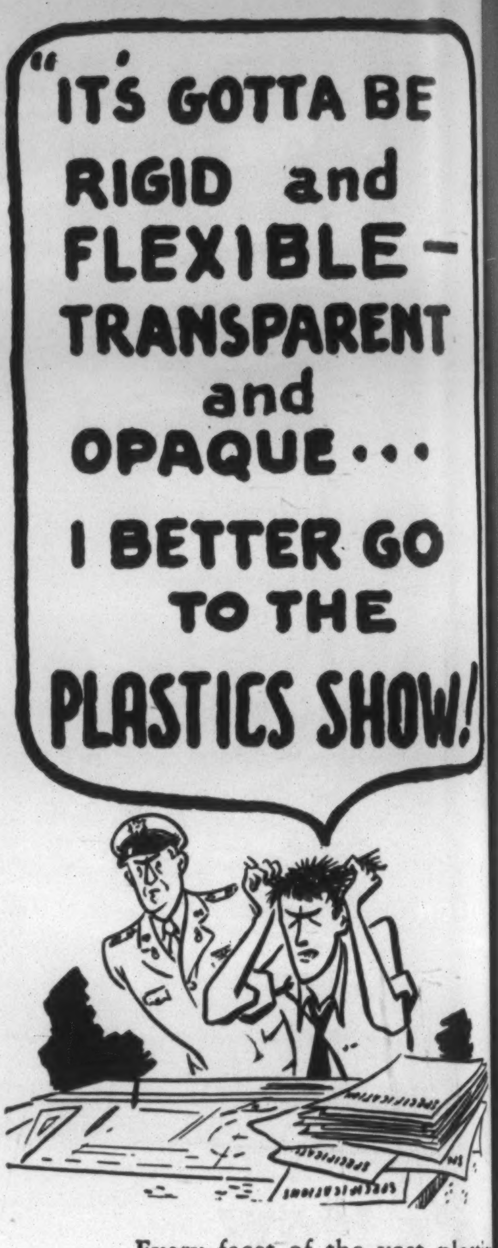
A bath of these materials can also be used with advantage for the treatment of many tools, dies, fixtures, gages, etc., made of medium or high carbon and alloy steels. The proper addition of these compounds produce the necessary carbonaceous cover on the bath surface, reducing the rate of cyanide decomposition and heat radiation losses.

Polishing Applicator and Abrasive Combined in One Unit

Available in a wide variety of sizes for either hand or mechanical use from *Embree Manufacturing Co.*, Elizabeth 4, N. J., new polishing units are constructed of cotton (other fibrous materials upon request), impregnated throughout with any one of a wide variety of polishing, buffing, oiling or other compounds, and then ma-



These polishing units are impregnated with any one of a wide variety of polishing, buffing, oiling or other compounds.



"IT'S GOTTA BE RIGID and FLEXIBLE– TRANSPARENT and OPAQUE... I BETTER GO TO THE PLASTICS SHOW!

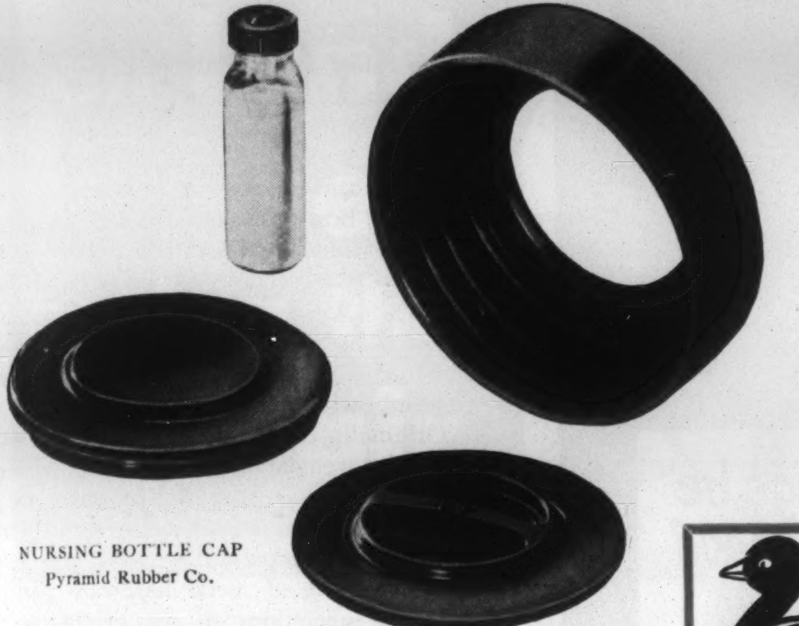
Every facet of the vast plastic industry will be concentrated in Philadelphia's Convention Hall. You will se what's *new* in research, raw materials, machinery, and production techniques. If there's an answer to your problem i the plastics industry, you'll find it at th Exposition. *This exposition is not ope to the public. Requests for admission tickets should be written on your company letterhead directed to* THE SOCIETY OF THE PLASTICS INDUSTRY, Inc., 67 W. 44th Street, New York 18, N.Y.

1952 NATIONAL PLASTICS EXPOSITION

PHILADELPHIA CONVENTION HALL

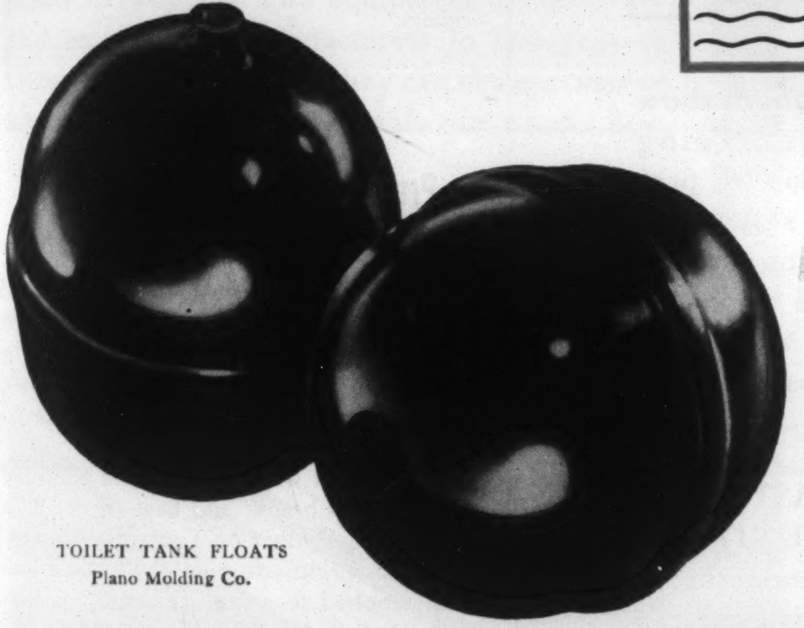
MARCH 11 – 14, 1952

WATER can't cramp your product's performance

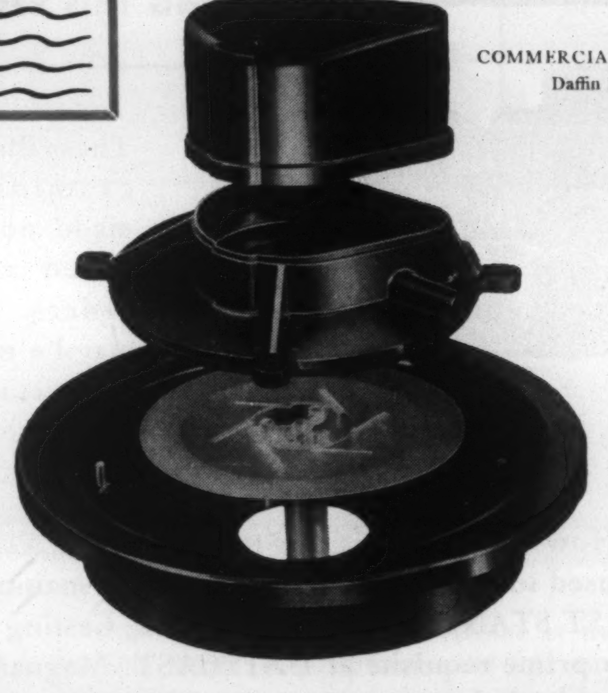


NURSING BOTTLE CAP
Pyramid Rubber Co.

ENGINE DEHYDRATOR
Clark Metal Products Co.



TOILET TANK FLOATS
Plano Molding Co.



COMMERCIAL HUMIDIFIER
Daffin Mfg. Co.

. . . when it's custom molded of DUREZ phenolics

● Water resistance should seldom be overlooked in materials selection, and often it is a controlling factor.

This characteristic is outstanding in Durez phenolics and, as these examples suggest, it can serve you in many ways. Frequent contact with hot liquid causes no deterioration in the sanitary screw-on nursing bottle cap and nipple holder. Toilet tank balls of Durez float for years. Engine dehydrator plugs are unaffected by any climatic conditions and have the torque strength needed for a tight screw fit. Constant exposure to water vapor neither swells, shrinks nor warps the humidifier parts of molded Durez, nor mars their lustrous finish.

In millions of pieces of electrical and electronic equipment the low water absorption of Durez is equally important...it safeguards the excellent electrical characteristics of the material.

Your custom molder will help you get maximum profit from the electrical, chemical, and mechanical properties available in more than 300 Durez molding compounds. Why not see him now, before future plans become 'set'? Our field staff is at your service for details and technical assistance.

DUREZ

PHENOLIC RESINS
- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- PROTECTIVE COATING RESINS

Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead, to Durez Plastics & Chemicals, Inc., 1401 Walck Road, North Tonawanda, N. Y.

PHENOLIC PLASTICS THAT FIT THE JOB

WHAT ARE YOUR REQUIREMENTS ?

Must your castings be Magnaflux examined?

. .UNITCAST DAILY PRODUCES CASTINGS MEETING THIS REQUIREMENT!

These illustrations show examinations being made on quantity produced and short run orders. Examinations may be made by wet or dry method, as well as Magnaglo particle inspection.

How extensively is this tool used by UNITCAST? It is used to determine, improve, and to maintain UNITCAST STANDARD OF QUALITY. Casting soundness is a prime requisite at UNITCAST. Magnaflux is used extensively here, as a spot check, even though customer specifications do not include the use of this additional quality control factor. Why not let your problems become ours to control.

UNITCAST
Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

New Materials and Equipment

chine rolled in cellulose tissue with both ends exposed for use.

Since Rollies combine the required ingredients and the vehicle of application into one convenient unit, this new device is said to bring substantial new economies to many finishing operations. Time and labor costs are claimed to be reduced up to 50%. Waste of expensive compounds is ended because the product supplies the ingredient to the working surface at a constant rate for maximum efficiency.

Originally created for consumer use as a more convenient way to clean and polish metals as well as glass and porcelain surfaces, Rollies have already attracted interest from several industrial fields. These include finishing of metal hardware parts, polishing operations in the manufacture of jewelry, protective oiling of metal surfaces subject to rust during shipping and storage, buffing and polishing of optical and other lenses, furniture finishing and others.

Precision Built Locknut Offers Unusual Advantages

A new development in the fastener field is currently being offered to industry by *E. A. Bessom Corp.,* Salem, Mass. The new product is a constant torque precision built locknut which is said to require no other locking device.

Constructed with a flange and tempered dieset ribbed barrel, and heat treated to a spring temper, the Con-Torq affords a concentrated spring action of such power, that when applied to a bolt or screw, the nut is claimed to defy vibration, moisture, extremes of heat or cold, or any other condition to shake it loose.

Other advantages of the locknut are: it will not injure screw threads; it is lightweight; it locks securely in any position of the screw, and retains its original grip after countless removals.

New Model Wet Blasting Unit Introduced

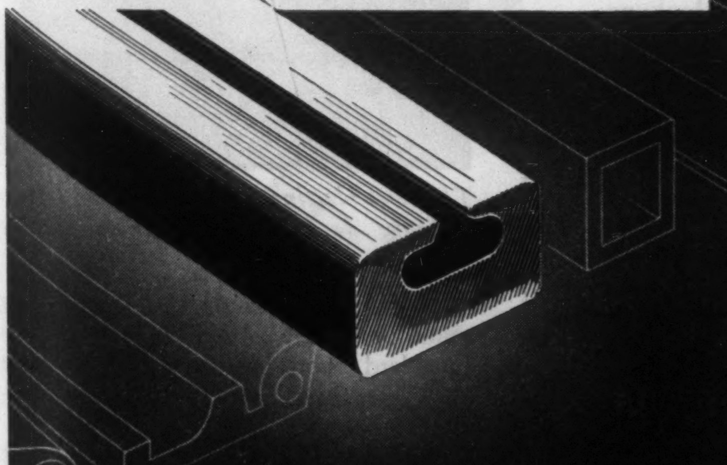
The Cro-Plate Co., Inc., 747 Windsor St., Hartford 5, Conn., has announced the availability of the newly redesigned Pressure-Blast, Jr. This new bench model wet-blasting unit features the elimination of the usual troublesome pump, replacing the pump function by the siphoning action of the compressed-air operated jet gun.

Used for deburring, descaling and general surface cleaning, the blaster is easily

on land, sea and in the air

Acadia Synthetic Rubber Products are once again in great demand for the nation's defense. They are serving in a large variety of important purposes in weapons and equipment on land, sea and in the air. Manufacturers in hundreds of industries have learned they can always depend upon the uniformly high quality of Acadia Synthetic Rubbers.

They are readily compounded to exact degrees of elasticity, resilience, plasticity: offer high resistance to oil, age, light, temperature extremes. They can be molded or extruded—cut to close tolerances in endless shapes and sizes.



sheets • tubing • strips • channel • washers • seals • bellows • gaskets • rings • extrusions • cut parts

ACADIA Synthetic PRODUCTS

Processors of Synthetic Rubber and Plastics • Sheets • Extrusions • Molded Parts

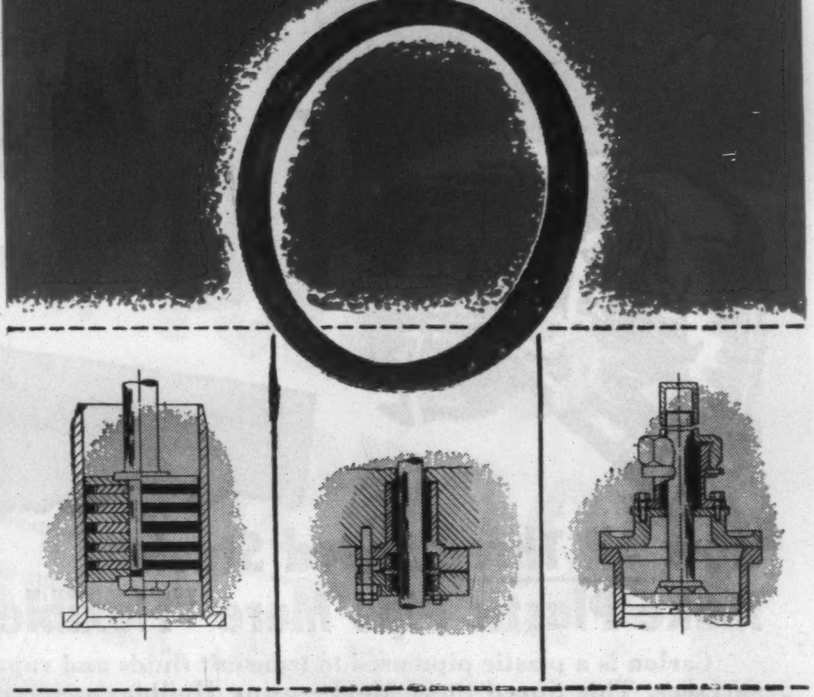
DIVISION WESTERN FELT WORKS

4035-4117 Ogden Avenue, Chicago 23, Illinois

RETAIN PURITY by installing MORGANITE

SELF-LUBRICATING • NON-CONTAMINATING

PISTON RINGS



IN COMPRESSORS, handling foods, chemicals, plastics, beverages and oxygen.

Completely efficient lubrication is inherent in the rings themselves — no oil or other lubrication is required during the life of the ring. Morganite Piston Rings are non-contaminating and impart no taste or odor. Ideal for compressors in oxygen service. Self-lubricating Morganite is also available in rotary seals, washers, valves, bearings, vanes, and other parts.

CONSULT OUR CATALOG in Sweet's File for Product Designers. Call or write for complete engineering data and recommendations on specific problems. Please supply drawings and specifications when requesting estimates.

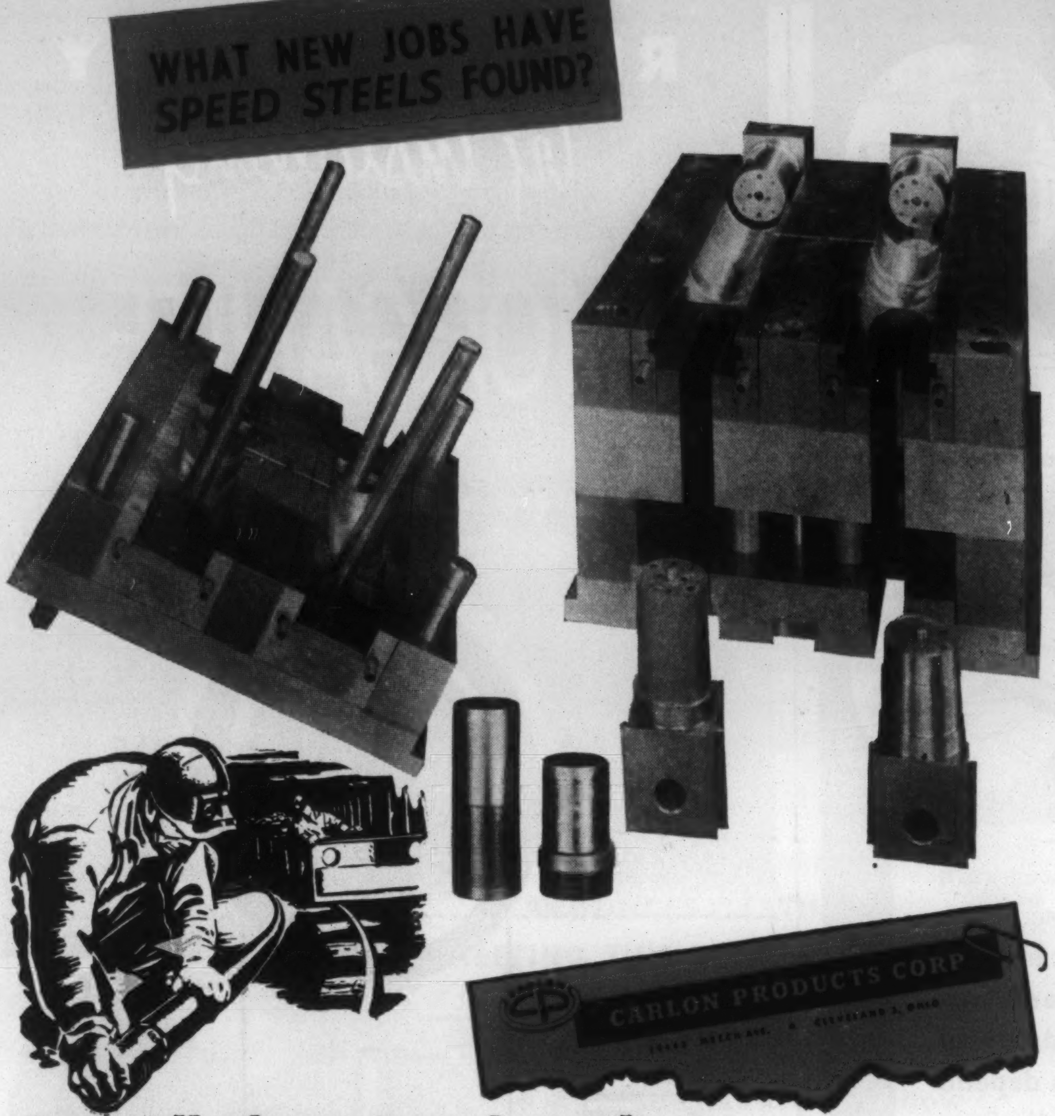
see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

REGISTERED TRADE MARK

Morganite INCORPORATED

LONG ISLAND CITY 1, NEW YORK

Manufacturers of CARBON MOTOR and GENERATOR BRUSHES, CARBON PILES and SELF-LUBRICATING CARBON SPECIALTIES



How All Three Speed Steels Make Plastic Pipe More "Flexible"

Carlon is a plastic pipe used to transmit fluids and vapors over irregular surfaces. This Speed Steel Mold—using Holliday's Speed Case (X1515), Speed Treat (X1545) and Speed Alloy hot rolled alloy plate steel helps make Carlon even more "flexible". It molds 6" dia. threaded plastic couplings that join either long lengths of Carlon to Carlon or Carlon to standard metal pipe.

Naturally, these couplings have to be near-perfect to prevent leakage. Carlon Products Corp. reports top distortion-free production at the rate of one shot per minute. Houk Machine Company, Barberton, Ohio who made the mold of Speed Steels for Carlon, reports 40% faster machining than regular hot rolled carbon or tool steels plus an absence of warpage and distortion and longer tool life. Top and bottom plates are of ground Speed Treat plate, male and female core are of Speed Case carburized to Rockwell 55 "C" then ground to size. Other parts are of Speed Alloy.

How versatile Speed Steels are solving new fabricating problems every day makes mighty profitable listening. Check with your Speed Steel distributor or write direct for literature.

SPEED STEELS

W. J. HOLLIDAY & CO. SINCE 1856 INC.

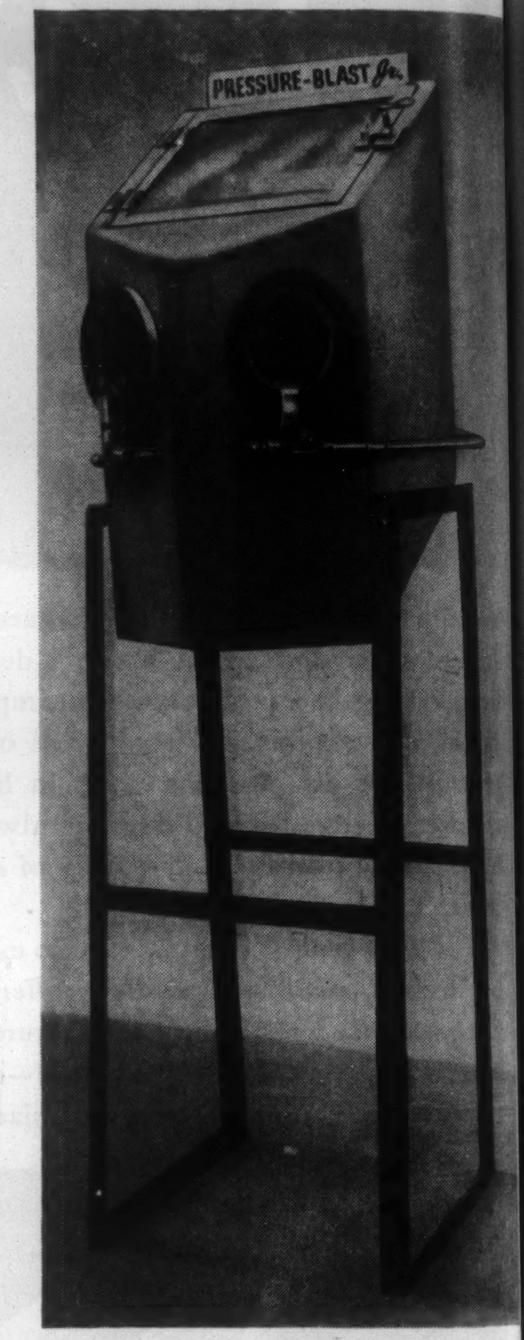
SPEED ALLOY ■ SPEED CASE ■ SPEED TREAT

DISTRIBUTED BY

Brown-Wales Co., Boston-Hartford-Lewiston, Me. ■ Bridgeport Steel Co., Bridgeport, Conn. Beals, McCarthy & Rogers, Buffalo, N. Y. ■ Burger Iron Co., Akron, Ohio ■ Grammer, Dempsey & Hudson, Inc., Newark, N. J. ■ Earle M. Jorgensen Co., Los Angeles-Houston-Oakland-Dallas ■ Passaic County Steel Service, Inc., Paterson, N. J. ■ Peckover's Ltd., Halifax-Montreal-Toronto-Winnipeg-Vancouver ■ Peninsular Steel Co., Detroit, Mich. Pidgeon-Thomas Iron Co., Memphis, Tenn. ■ Horace T. Potts Co., Philadelphia-Baltimore

Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

New Materials and Equipment



This wet blasting unit is designed for deburring, descaling and general surface cleaning.

installed, requires only one ⅜-in. water connection, one ⅜-in. air connection (standard shop pressure) and a single 110-v line for blower operation and lighting.

Constructed of stainless steel with sweat copper plumbing, the new model uses any abrasive from 75 to 5000 mesh.

Phenolic Compound Affords Savings in Cure Time

A new fast-cure phenolic compound has been developed by the Chemical Div., *General Electric Co.*, Pittsfield, Mass., that is said to speed cure time on molded parts.

Designated G-E 12853, the new compound is recommended for those applications presently being molded with general

ALLOY STEEL UNNECESSARY!

COSTS CUT IN HALF

Excellent

WEAR RESISTANCE

Obtained . . .

with GROUND and POLISHED STRESSPROOF STEEL BARS®

In this Kearney & Trecker new Model CK vertical milling machine, the 2" diameter feed screw (right) is made from Ground and Polished STRESSPROOF

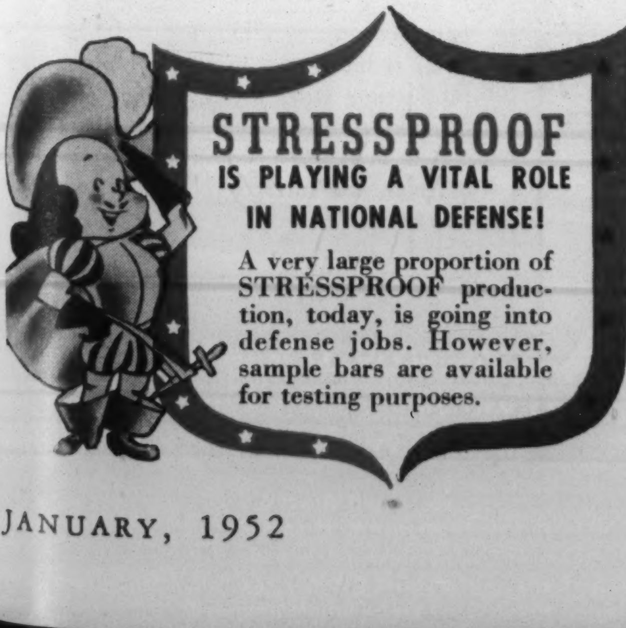
FOUR OPERATIONS ELIMINATED

- QUENCHING
- TEMPERING
- STRAIGHTENING
- FINISH GRINDING

Ground and Polished STRESSPROOF has been used for lead and feed screws by Kearney & Trecker since 1939. If STRESSPROOF were not available, they would need a .50% carbon-alloy steel to obtain the required strength and wear-resistant properties. The substitution of alloy would require quenching and tempering, straightening and finish grinding—operations not necessary with Ground and Polished STRESSPROOF. The cost of the part would be more than doubled.

For precision work, lead and feed screws for machine tools must maintain their accuracy through years of operation. Ground and Polished STRESSPROOF cuts cost for these exacting parts because it provides *five* qualities in the bar—(1) *high strength*, double that of ordinary cold-finished shafting; (2) *machinability*, fully 50% better than heat-treated alloys of the same hardness; (3) *high resistance to wear*, replacing many heat-treated or carburized alloys; (4) *minimum warpage*, obtained by special processing; and (5) *accurate, finely ground surface.*

It is significant that the only suitable substitute for STRESSPROOF is an alloy steel requiring many additional expensive production operations.



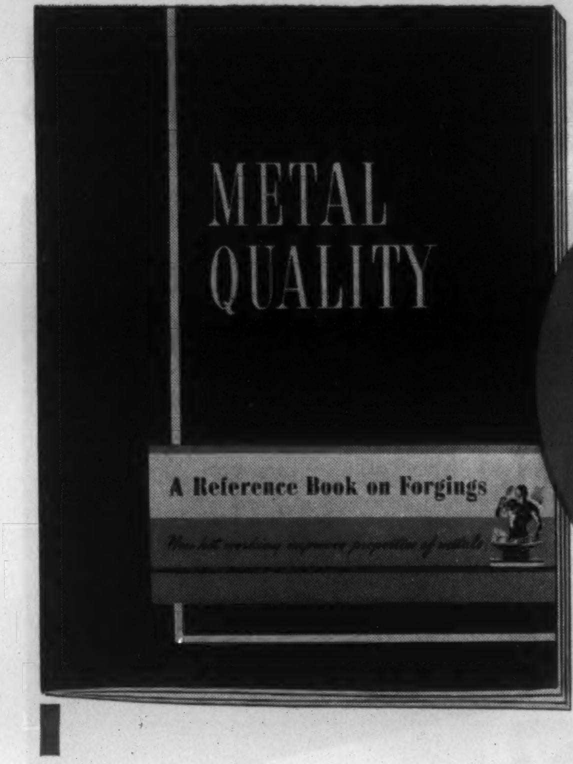
STRESSPROOF IS PLAYING A VITAL ROLE IN NATIONAL DEFENSE!

A very large proportion of STRESSPROOF production, today, is going into defense jobs. However, sample bars are available for testing purposes.

LaSalle STEEL CO.

1418 150th Street, Hammond, Indiana

Manufacturers of the Most Complete Line of Cold-Finished and Ground and Polished Bars in America


METAL QUALITY
A Reference Book on Forgings
How hot working improves properties of metals

Engineering, production and economic advantages obtainable with forgings are presented in this Reference Book on forgings. Write for a copy.

Forgings fortify a mechanism with a factor of greater safety that is otherwise unobtainable . . . There is no substitute for the toughness and strength inherent in the compact, fiber-like flow line structure of closed die forgings. Consult a Forging Engineer about the correct combination of mechanical properties which forgings can provide for your product.

DROP FORGING ASSOCIATION
605 HANNA BLDG. • CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal", 1949 Edition.

Name ....
Position ....
Company ....
Address ....

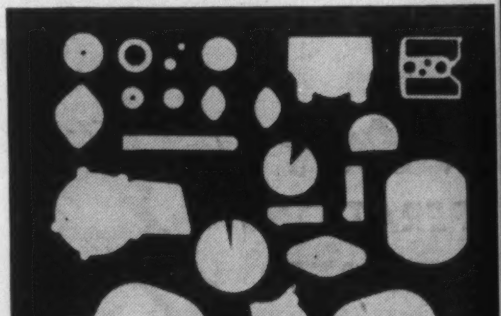
purpose phenolic materials. Optimum results are possible in compression, transfer and plunger type molds.

Capable of being preheated to higher temperatures than conventional general purpose materials, the compound's cure time is claimed to be substantially reduced; and in many cases, the molding of intricate parts is simplified. Preheating and mold temperatures can be widely varied to regulate flow, permitting the use of G-E 12853 for a variety of applications. This versatility enables the molder to reduce the number of materials that he would otherwise stock.

Combining good physical and electrical properties, the compound imparts good finish and high gloss to molded parts. According to the manufacturer, preforming characteristics are excellent and any common method of finishing can be utilized.

Pressure-Sensitive Masks for Finishing

The By-Buk Co., 4314 W. Pico Blvd., Los Angeles 19, has developed an improved pressure-sensitive-type paper mask which is said to enable fast, accurate masking for production line spray or brush painting and sandblasting. As much as 90% reduction in man-hours plus higher production with lower material cost are claimed through the use of this custom die-cut mask. Over-masking down the sides or over the surfaces is eliminated, since every mask exactly fits the area to be protected.


These custom die-cut masks enable fast, accurate masking for production line spray or brush painting and sandblasting.

Accurate, but inexpensive dies are made. Special die-cut presses with die capacities up to 20 in. by 36 in. cut the exact specification of size and shape of the area to be masked.

A special grade of pressure-sensitive ad-ment

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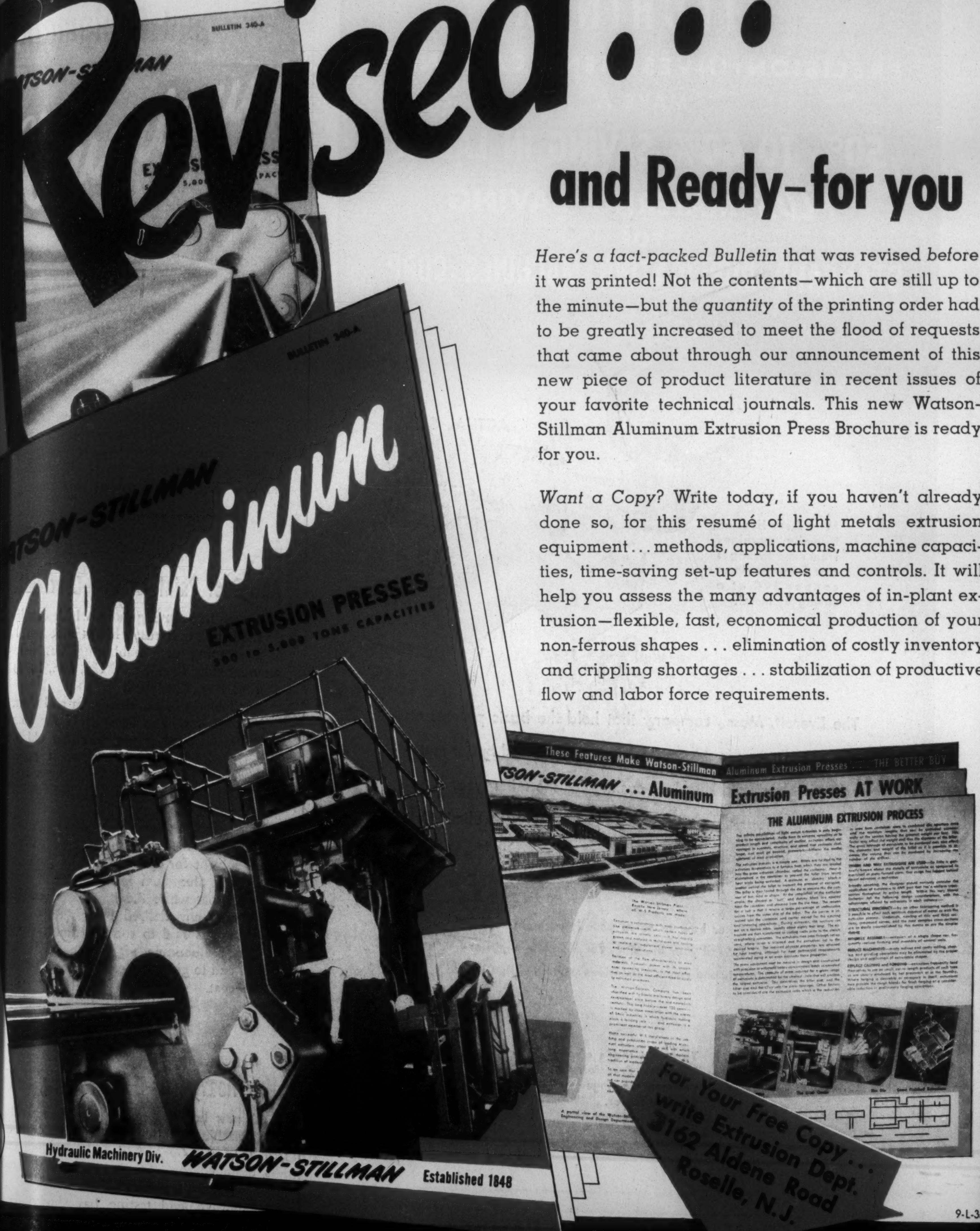
Revised...

and Ready–for you


BULLETIN 340-A
WATSON-STILLMAN
EXTRUSION PRESSES
BULLETIN 340-A
WATSON-STILLMAN
Aluminum
EXTRUSION PRESSES
500 to 5,000 TONS CAPACITIES
Hydraulic Machinery Div.
WATSON-STILLMAN
Established 1848
These Features Make Watson-Stillman Aluminum Extrusion Presses ... THE BETTER BUY
WATSON-STILLMAN ... Aluminum Extrusion Presses AT WORK
THE ALUMINUM EXTRUSION PROCESS

Here's a fact-packed Bulletin that was revised *before* it was printed! Not the contents—which are still up to the minute—but the *quantity* of the printing order had to be greatly increased to meet the flood of requests that came about through our announcement of this new piece of product literature in recent issues of your favorite technical journals. This new Watson-Stillman Aluminum Extrusion Press Brochure is ready for you.

Want a Copy? Write today, if you haven't already done so, for this resumé of light metals extrusion equipment . . . methods, applications, machine capacities, time-saving set-up features and controls. It will help you assess the many advantages of in-plant extrusion—flexible, fast, economical production of your non-ferrous shapes . . . elimination of costly inventory and crippling shortages . . . stabilization of productive flow and labor force requirements.

For Your Free Copy...
write Extrusion Dept.
3162 Aldene Road
Roselle, N.J.

9-L-3

HYDRAULIC MACHINERY DIVISION **WATSON-STILLMAN** **ESTABLISHED 1848**

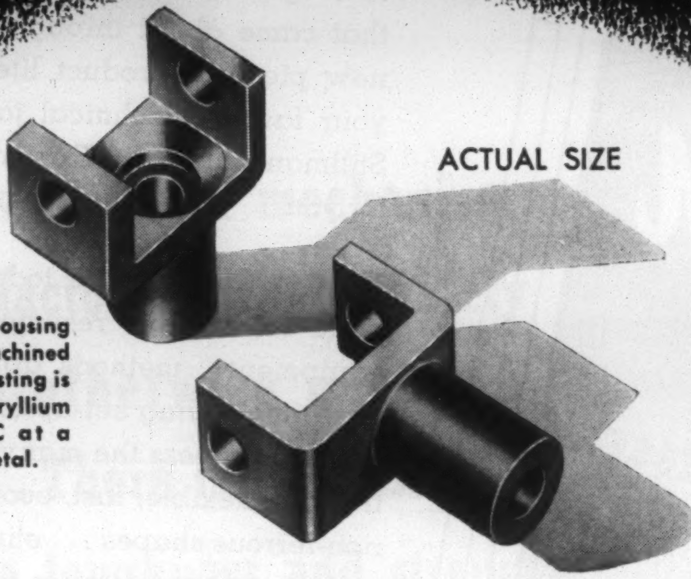
Factory and Main Office: Roselle, New Jersey

ranch Office: 228 N. LaSalle, Chicago, Ill. • **Manufactured in Canada by—Canadian-Vickers, Ltd., Montreal**

REPRESENTATIVES

kron, Ohio	Watson-Stillman Co.			Portland, Ore.	Machinery & Tool Supply Co.
irmingham 3, Ala.	George M. Meriwether			San Francisco 7, Cal.	Schellenbach Mach. Tool Co.
uffalo, N. Y.	Don W. Patterson Co.	Indianapolis 20, Ind.	Millholland Machinery Co.	Seattle, Wash.	Machinery & Tool Supply Co.
allas, Texas	M & R Sales Co.	Los Angeles 11, Cal.	H. M. Royal, Inc.	Spokane 8, Wash.	Machinery & Tool Supply Co.
enver 2, Colo.	Overgard Machine Tool Co.	Pittsburgh 19, Pa.	Stanley Berg & Co.	St. Paul 4, Minn.	Anderson Machine Tool Co.

HITCHINER
PRECISION INVESTMENT CASTINGS
MAKE A
50% TO 60% SAVING IN LABOR
PLUS MATERIAL SAVING
FOR
STANDARD DUPLICATING MACHINES CORP.



ACTUAL SIZE

Miter Gear Housing formerly machined from sand casting is cast from beryllium copper 20C at a saving of metal.

The Everett, Mass., company that held the basic patents on spirit duplicators is still on the alert for new and better methods. In selecting a Hitchiner casting for the miter gear housing shown, four time consuming operations were eliminated resulting in the exceptional saving in labor costs.

Ask Hitchiner how to solve your investment casting problems. Send your drawings for complete engineering analysis and recommendations without obligation.

To learn more about Hitchiner Precision Investment Castings send for free folder.

RIGHT WAY
HITCHINER

HITCHINER Manufacturing Company, Inc.
MILFORD 3, NEW HAMPSHIRE
Sales Office: 967 Farmington Ave., West Hartford 7, Ct. Representatives in principal cities

New Materials and Equipment

hesive is impregnated on the back of the tough paint and lacquer-resistant masking paper. The manufacturer claims it has sufficient adhesion to hold the edges down tight, but not enough to prevent easy peeling of the mask without marring or leaving a residue on the finished surface, and does not dry out or lose its sticking qualities. Special heat-resisting paper for bake ovens is also available.

A creped paper protection sheet is loosely attached to the adhesive surface, which remains in position for easy handling until the mask is to be applied, at which time it is quickly stripped off in one operation. When several different mask shapes or sizes are required for a single job, the manufacturer will supply the complete set, die-cut from one sheet, ready for quick handling by the masking operators. Free samples and quotations are available.

Anti-Rust Paint for Use Over Rust

A new labor-saving paint which can be applied right over rust without wire brushing, scraping or sandblasting has been announced by *The Monroe Co., Inc.*, 10703 Quebec Ave., Cleveland 6.

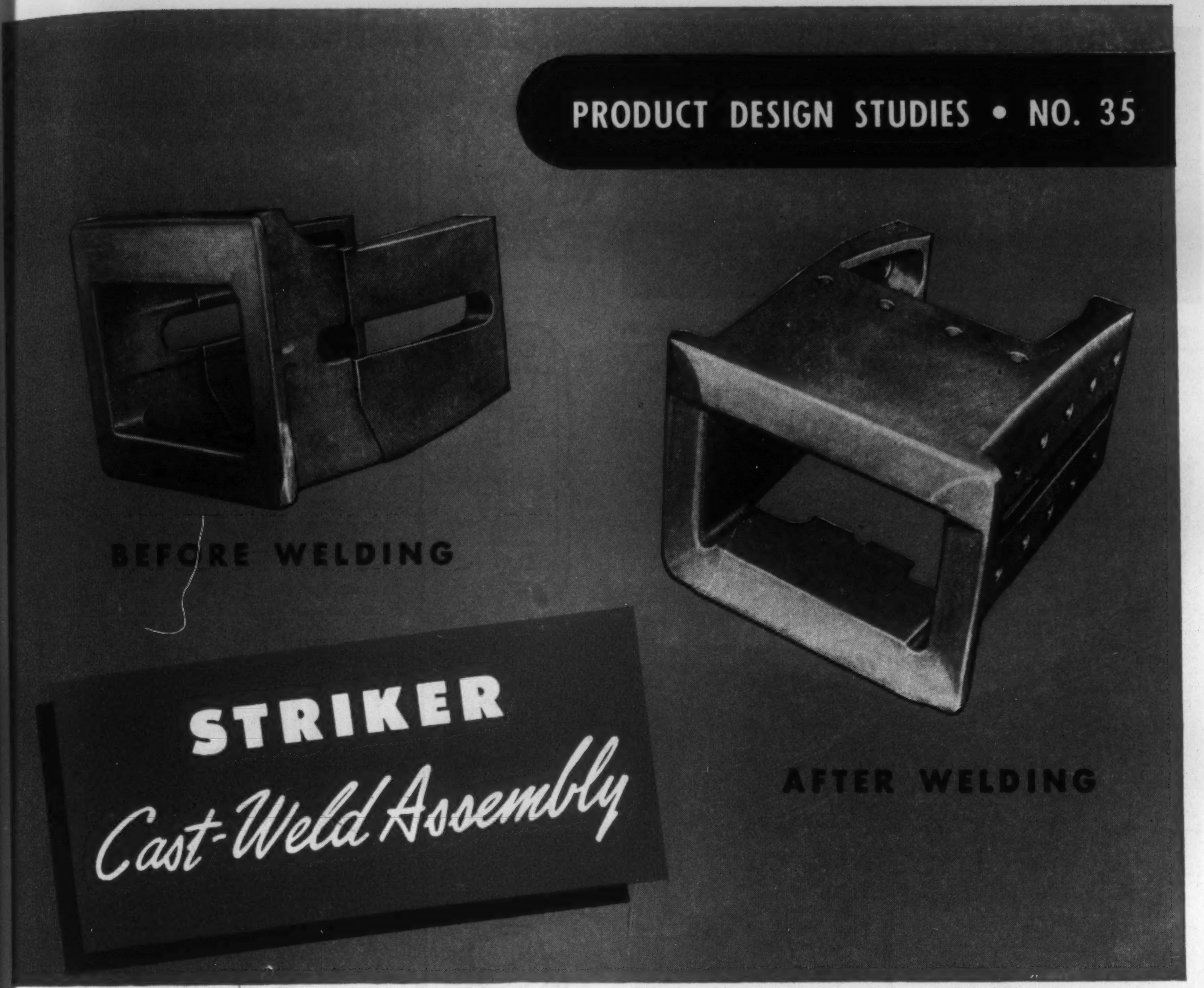
Available in black, aluminum and clear, Rust-Cure is said to be suitable for both interior and exterior use on either old or new metal. Upon application, it penetrates through any existent rust layer and effectively seals the surface against further rust action.

The new paint is compounded for brush application and can be thinned with Rust-Cure solvent for spray use. The paint in black and aluminum is for use solely as a finish coat while the clear paint can be used over any desired color. Rust-Cure aluminum is said to contain almost twice as much aluminum pigment as ordinary paints and to give an exceptionally brilliant finish coat.

New Heavy Duty D.C. Welding Unit

A new heavy duty direct current welding machine is now being offered by the *A. O. Smith Corp.*, Milwaukee. The unit is designed for all industrial uses where d.c. welding is required.

Extensive field testing has shown the machine to be free of stack failure, which is accomplished by directing a high velocity downdraft of cool air over the rectifier stacks before passing this air through other parts of the machine. The blast is expelled at the base of the welder. This not only



Number of Pieces Reduced 81%...Welding 50% with Cast-Weld Construction

The striker, a vital part of every freight car, protects draft gear and center sills from damage from impact of coupler horn.

Redesign of the striker from a weldment to a three-piece cast-weld assembly reduced the number of pieces from 16 to 3, and reduced lineal welding 50%. A further advantage of the cast-weld striker is ease of assembly.

The quality of this cast-weld assembly is evidenced by the fact that many thousand of these strikers have been produced with complete customer satisfaction.

* * *

Conversion of some of your parts to *foundry engineered* cast-weld assemblies and *foundry engineered* steel castings — through close cooperation of your engineering department and the steel foundry — may result in more production, of better quality, in less time and with less metal.

Your steel foundry representative will welcome an opportunity to make available to you his company's long experience *plus* the full results of the development and research program carried on by the Steel Founders' Society of America.

An Urgent Message About Scrap . . .

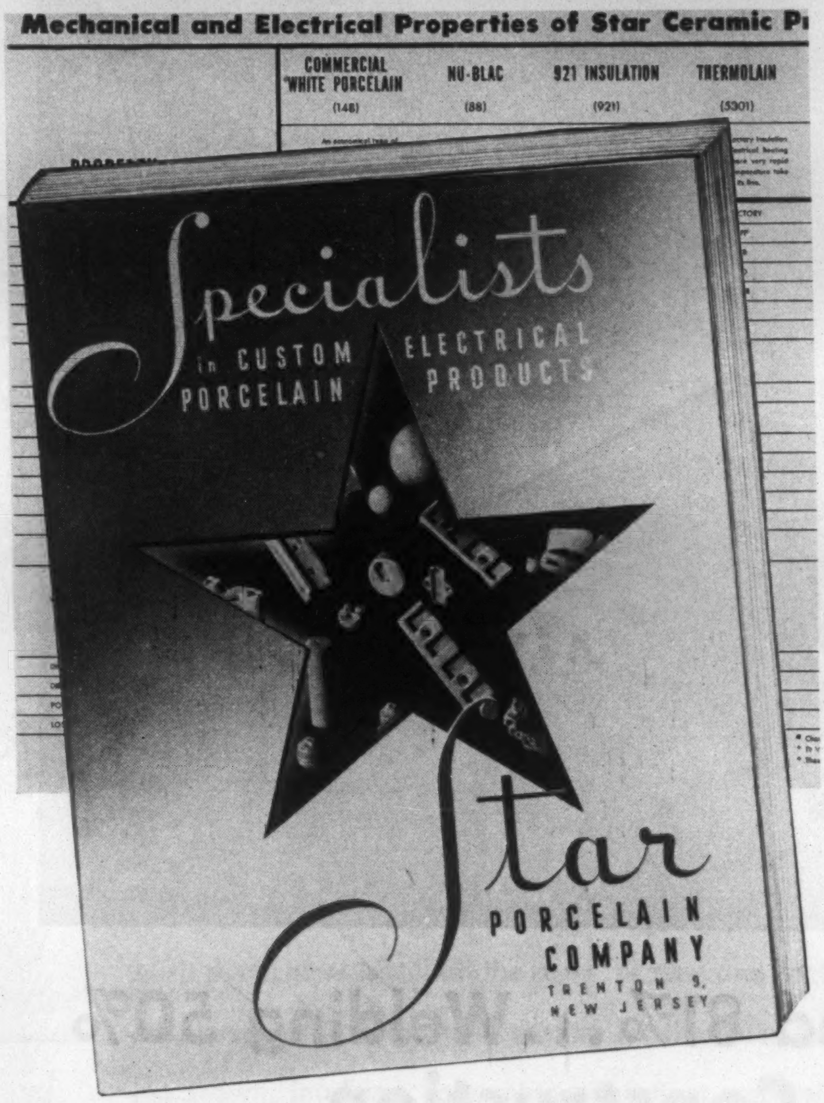
There is a serious shortage of iron and steel scrap. Your company can help insure the continued high production of all metal products by getting your scrap into the hands of your scrap dealer. Will you do what you can to help . . . now?

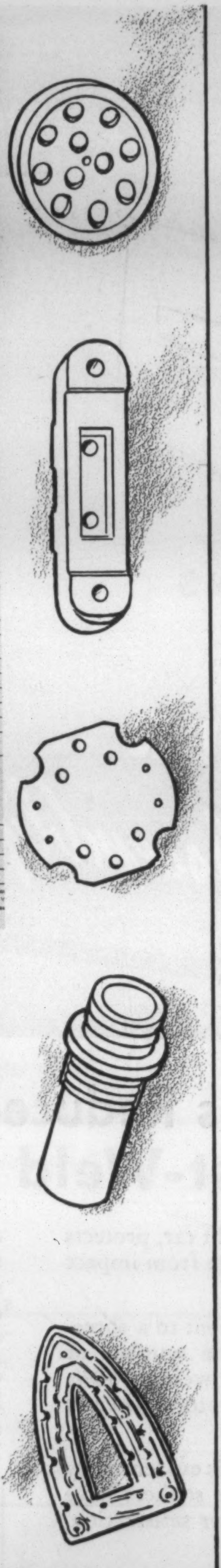
STEEL FOUNDERS' SOCIETY OF AMERICA
920 Midland Building
Cleveland 15, Ohio

Design and Build With Steel Castings

New ENGINEERING DATA *on* STAR PORCELAIN SPECIALTIES....

SEND FOR YOUR COPY TODAY


Mechanical and Electrical Properties of Star Ceramic Pr
COMMERCIAL WHITE PORCELAIN (148)
NU-BLAC (88)
921 INSULATION (921)
THERMOLAIN (5301)
Specialists in CUSTOM PORCELAIN ELECTRICAL PRODUCTS
Star PORCELAIN COMPANY
TRENTON 9, NEW JERSEY



Here is the kind of information you need for proper selection of ceramic bodies. It provides data on their electrical, thermal and mechanical characteristics . . . also helpful suggestions for design and application of porcelain parts.

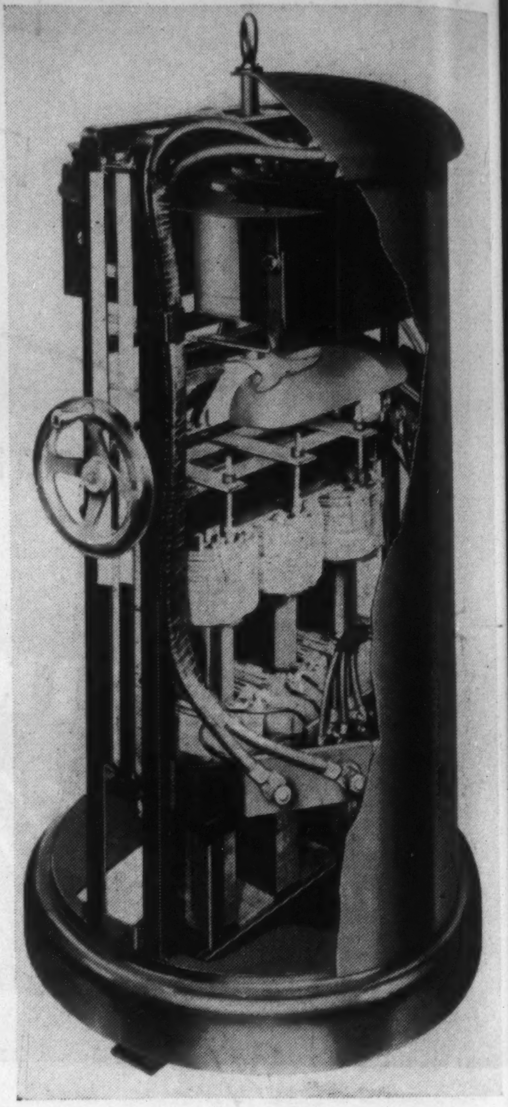
Take advantage of the know-how of STAR ceramic engineers. They have specialized in the development of specific formulae to meet the needs of the electrical and other industries. If you have a design or production problem involving porcelain, perhaps STAR engineers can help you find an economical, practical solution.

★ HUMIDOLAIN
★ LAVOLAIN
★ THERMOLAIN
★ VITROLAIN
★ NU-BLAC
★ COMMERCIAL WHITE

The STAR PORCELAIN COMPANY

MUIRHEAD AND JAY AVES. TRENTON, N. J.

New Materials and Equipment



This d.c. welding machine is available in 200-, 300- and 400-amp ratings.

assures proper cooling, but promotes internal machine cleanliness.

The company retains in this welder all of the principal construction features of its heavy duty a.c. unit. Among these features are the case-diameter fan and wind tunnel design to assure adequate, efficient flow over all energized parts. The primary coils are raised and lowered easily on ball bearing jacks. The unit is available in 200-, 300- and 400-amp ratings.

Protective Coating Combines Unique Properties

Coal tar pitch has been compounded by a recently developed process into a fast drying protective coating by breaking it down into minute molecules and then combining it with water and a stabilizing emulsification agent to form a permanent suspension that can be brushed or sprayed.

Available under the trade name Tarlac, and offered by *Flash-Stone Co., Inc.*, 30 E. Rittenhouse St., Philadelphia 44, the new coating is said to retain all the excellent protective and adhesive qualities of coal

HAVING TROUBLE GETTING CERTAIN MATERIALS

HERE'S SOMETHING TO THINK ABOUT

Today Chicago Molded Plastics are replacing aluminum, copper and brass at the rate of a million pounds a month. And . . . the replacement is usually found to be *better than the original.*

Naturally, we don't mean to imply that molded plastics will provide the answer to every problem. Far from it. But . . . modern plastic materials are doing some remarkable things today . . . things that would have been impossible a few years ago. So . . . maybe it would be a good idea to check into the matter and see where molded plastics might be used to advantage in *your* product. If you can save scarce materials on even one or two small parts used in quantity, it will mean a worthwhile improvement in your material position.

LET'S TALK IT OVER

We know the advantages and limitations of molded plastics. We know the characteristics and molding behaviors of all the various materials. We know because we've molded them all during our 32 years in the business. That's why we can quickly tell you whether yours is a practical plastics application . . . whether it would be to your advantage to even consider the use of plastics. And, of course, we have all the most modern facilities for compression, injection and transfer molding to meet your largest quantity requirements.

You'll find it time well spent to talk things over with a Chicago Molded engineer and get the benefit of this experience. So . . . why not write or phone today? No obligation.

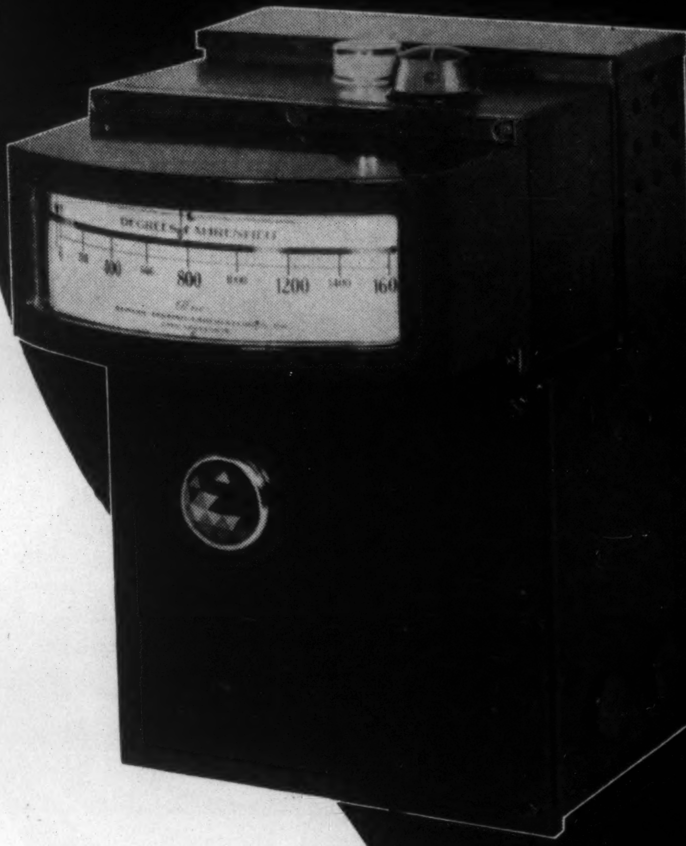
CHICAGO MOLDED

PRODUCTS CORPORATION

CMPC

1026-60 N. KOLMAR AVE. · CHICAGO 51, ILL.

CUSTOM MOLDERS OF ALL PLASTIC MATERIALS



HERE'S LOW-COST
POSITIVE TEMPERATURE CONTROL
with *Alnor* ACCURACY

Alnor
Temperature Controller

Now—at a cost far less than you may think—you can bring automatic precise temperature control to heat-treating furnaces, bake-ovens, etc.—in fact, to any heating device whether electrically heated or fuel fired. The Alnor Controller is simple in design and operation—you merely set the pointer at the desired cut-off temperature, and it's ready to give you the finest in accurate controller service on new or existing heating equipment. Alnor quality throughout, it features the famous double air gap pyrometer movement; easily read, 6-inch mirrored scale; automatic cold-end compensator; weather-proof, dust-tight case—a truly rugged, precise instrument at a price you can afford. Write today for complete information and price. Illinois Testing Laboratories, Inc., Room 522, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS
FOR EVERY INDUSTRY

New Materials and Equipment

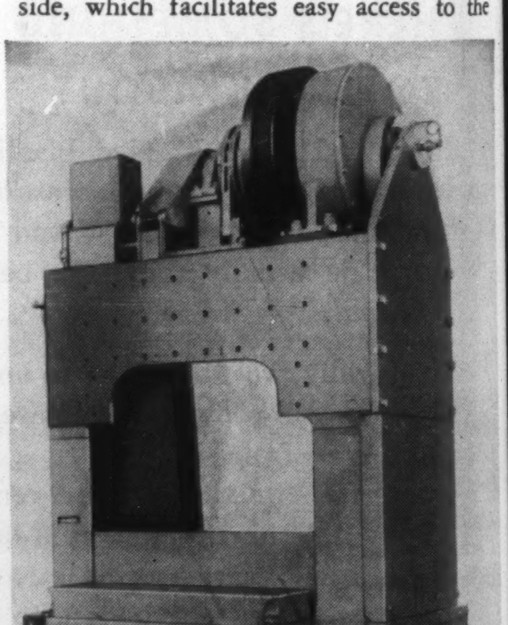
tar pitch, to be impervious to oils, greases, other petroleum derivatives, acids, alkalis, water and condensation. It will not crack at low temperature or run at high temperature, good from —56 to 200 F.

Tarlac dries to a tough, enduring, flat black film and is completely insoluble in water. It is recommended as a protective coating for concrete structures, floors, masonry, metals exposed to corrosive elements, mastic floors or other black top surfaces, and for general purpose protection.

Gap-Type Welding Press Permits Side-to-Side Feeding

Development of a gap-frame welding press for use with welding fixtures in the mass production of spot welded assemblies has been announced by *E. W. Bliss Co.*, Canton, Ohio.

The gap style frame is designed to permit conveyorized feeding from side to side, which facilitates easy access to the work by the operators. Work is accessible from either front or back of the press.



This gap frame welding press is designed for use with welding fixtures in the mass production of spot welded assemblies.

The slide is located in the lower portion of the press and the work stroke is upward. Parts to be welded are laid on the lower die, which contains welding tips, and moved up into contact with the fixed welding tips attached to the upper part

New G-E Machine for Progressive Heating

handles many different parts for hardening or annealing with induction heat

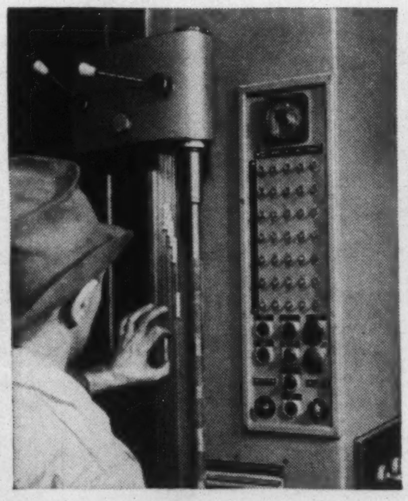
If your production requirements include hardening or annealing selected areas on shafts, pinions, rods, spindles or plungers, then you need the new HM 40 PV heat-treating machine because it . . .

- **handles a wide range of work to 40 inches length and three inches diameter**
- **can be set up or changed over from job to job quickly and easily**
- **cycles automatically to assure duplication of results**
- **can be easily adapted for use with either electronic or motor-generator type induction heat power source**
- **increases flexibility by performing multiple heat-treating operations in a single pass**

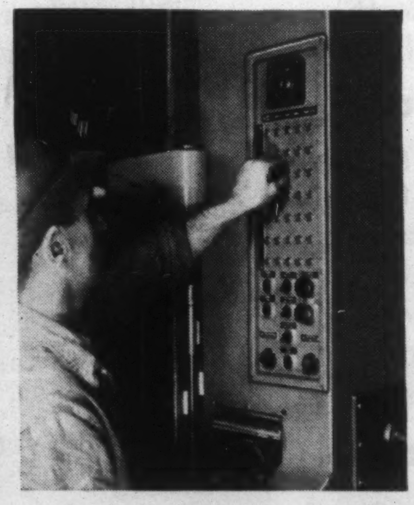
This versatile machine and a G-E induction heater are ideally suited for shops where a variety of parts must be treated, and their quantities do not justify individual fixturing.

For more information, call your nearby G-E Sales Office, or clip the coupon below.

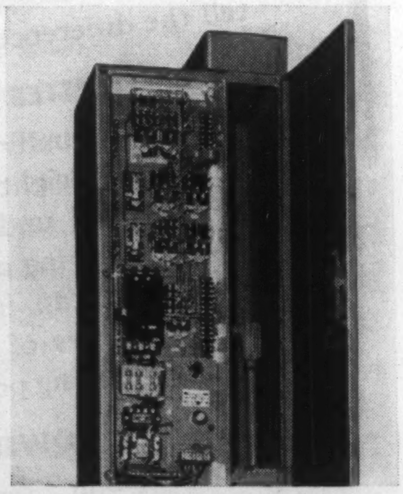
Quick reloading is possible because the controls are so convenient for the operator. Centers are spring-mounted, and either standard point or cup-type can be used.



The machine is quickly and easily set up to handle large or small production requirements. Place numbered tabs opposite areas to be heated and quenched, then . . .

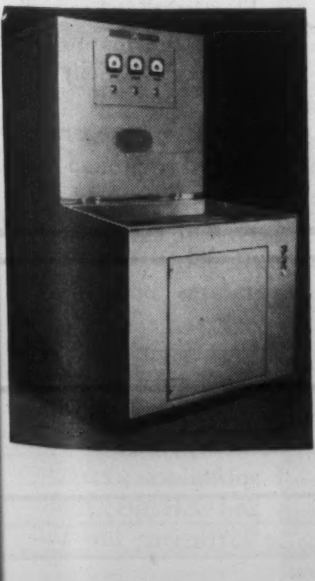


. . . finish the set-up by setting the proper toggle switches on the convenient control panel for heat, quench, dwell and rotate functions.



After set-up or change-over is finished, the Thy-mo-trol* control automatically carries out the cycle again and again to give uniform heat-treating results.

* *Registered trade-mark, General Electric Co.*



The new standard 20-kw electronic induction heater makes an ideal partner for the HM 40 PV heat-treating machine. This heater can also be used alone for many selective heating applications. Whether you are annealing, brazing, soldering or hardening, it can help you do any or all these jobs faster, better and at lower cost.

Section E 720–53, General Electric Co., Schenectady 5, N. Y.

Please send me a free copy of the following bulletins:

☐ for reference ☐ for immediate project

☐ GEA-5682, Type HM 40 PV Heat-treating Machine

☐ GEA-5594, New, Standard 20-kw Induction Heater

Name..........

Company..........

Street..........

City.......... State..........

GENERAL ELECTRIC

BRIGHT FINISHING SYSTEM

SPARKLES

LIKE CHROME!

Leading manufacturers approve zinc plate

and **IRIDITE®** *Bright*

to replace conventional chrome plating

If your problem is finding the right finish to replace conventional chrome plating, follow the lead of prominent manufacturers of all types of products . . . switch to zinc plate and Iridite Bright.

Here's what you get when you use this chromate finishing system to replace conventional chrome plating.

SPARKLING BRIGHT APPEARANCE

The zinc plate and Iridite Bright system resembles chrome so closely that visual inspection can scarcely tell the difference! And, the brilliance *lasts*.

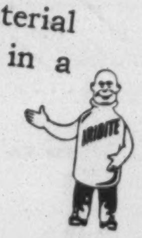
BETTER CORROSION PROTECTION

Yes, you actually get better protection with zinc plate and Iridite Bright than with chrome plating . . . up to twice the life under accelerated salt spray conditions! And, by applying a clear baking lacquer over the Iridite coating you can increase the abrasion resistance and lasting qualities of this bright finishing system, at the same time making possible a greater salt spray protection.

LOWER FINISHING COSTS

One metal, zinc, replaces three so you save material costs and plating time. Iridite Bright goes on in a non-electrolytic chemical dip.

Write or call today for your copy of our new Technical Bulletin describing all phases of this bright finishing system in detail. Tell us your bright finishing requirements. If possible send sample parts for test processing.



Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
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REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES; West Coast: L. H. BUTCHER COMPANY
Manufacturers of Iridite Finishes
for Corrosion Resistance and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals.

New Materials and Equipment

of the press. The slide dwells in the upper position, holding the parts in contact with the electrodes until welding is completed.

Other parts include a pneumatic friction clutch, flywheel and motor which are located at the top of the press for cleanliness and accessibility. Work stroke is adjustable and shut height is the same for all adjustments. Operating cycle is divided into thirds—120 deg for upstroke, 120 deg dwell, 120 deg downstroke. Each portion of the cycle is said to take a fraction of a second, and the machine can be started and stopped at any point in the cycle under load.

Slide widths on present models range from 42 to 84 in., with 12-in. depth on all widths. Larger or smaller dimensions can be built to order.

Rubber-Impregnated Leather Packings Offer Improved Sealing Ability

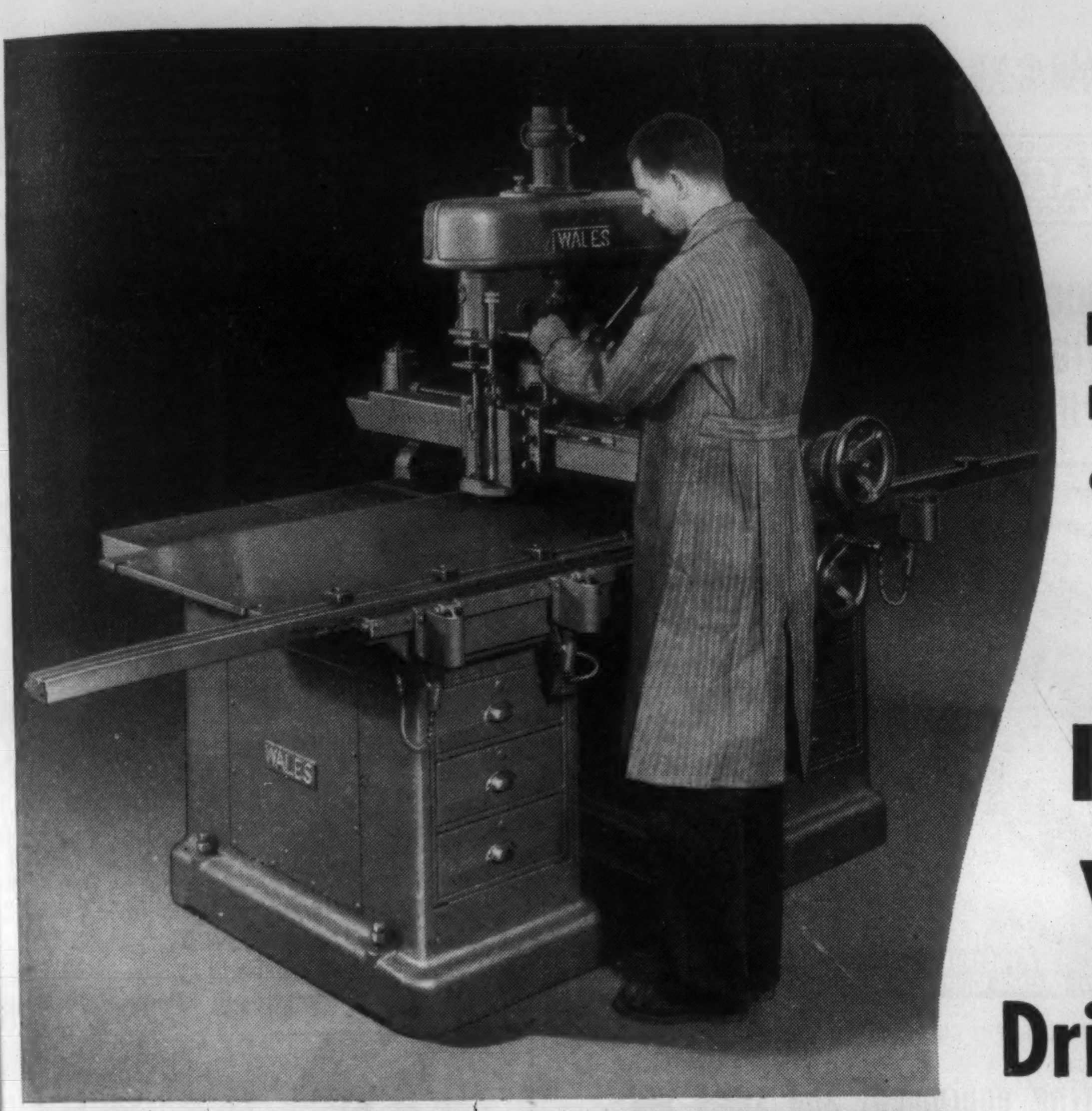
Announcement of a new type of rubber-impregnated leather packing has been made by *E. F. Houghton & Co.*, 303 W. Lehigh Ave., Philadelphia 33.

Known as No. 1243 Vim leather packing, the new product is said to offer distinct advantages over either synthetic rubber or wax-impregnated leather. It combines the lower friction and greater strength of leather with the perfect sealing, resilience and heat resistancy of rubber.

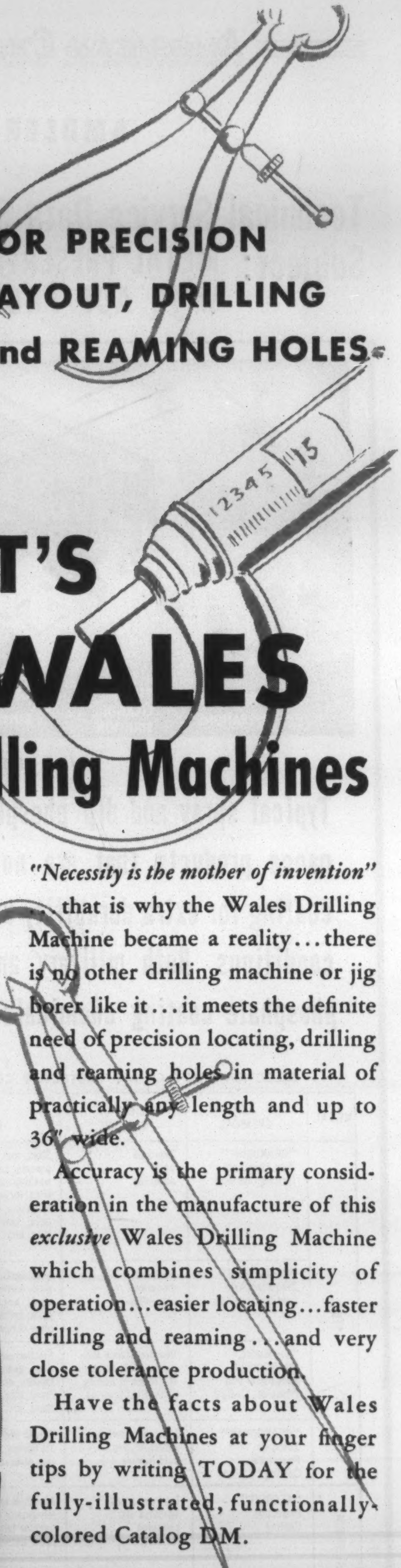
Made from long-fiber mineral-tanned Vim leather, the packing is completely impregnated with a selected synthetic elastomer. The bond between the leather and rubber is completed by a special polymerization process. This is emphasized as an all-way through impregnation, not merely a surface treatment. The result is said to be a pliability heretofore found only in rubber packings, so that the packing can be squeezed double in the hand, then rebounds to exact proportions when released. This resilience or elasticity means easier application.

Former types of impregnants were based on waxes which soften at around 150 F. The rubber impregnant has no low melting point, therefore will seal better, and the impregnant will not wash out of the packing at temperatures between 150 F and 200 F.

According to the manufacturer, the packing's advantages can be summed up as follows: Improved sealing ability because of high resiliency; ease of assembling, because of springiness; exceptional resistance to oils and solvents; resistance to plastic flow or extrusion; low friction



Showing the Wales Drilling Machine in operation. Note the large size template with holes being drilled on large unobstructed table.



FOR PRECISION LAYOUT, DRILLING and REAMING HOLES

IT'S WALES Drilling Machines

"Necessity is the mother of invention" ... that is why the Wales Drilling Machine became a reality ... there is no other drilling machine or jig borer like it ... it meets the definite need of precision locating, drilling and reaming holes in material of practically any length and up to 36" wide.

Accuracy is the primary consideration in the manufacture of this *exclusive* Wales Drilling Machine which combines simplicity of operation ... easier locating ... faster drilling and reaming ... and very close tolerance production.

Have the facts about Wales Drilling Machines at your finger tips by writing TODAY for the fully-illustrated, functionally-colored Catalog DM.

WALES-STRIPPIT CORPORATION

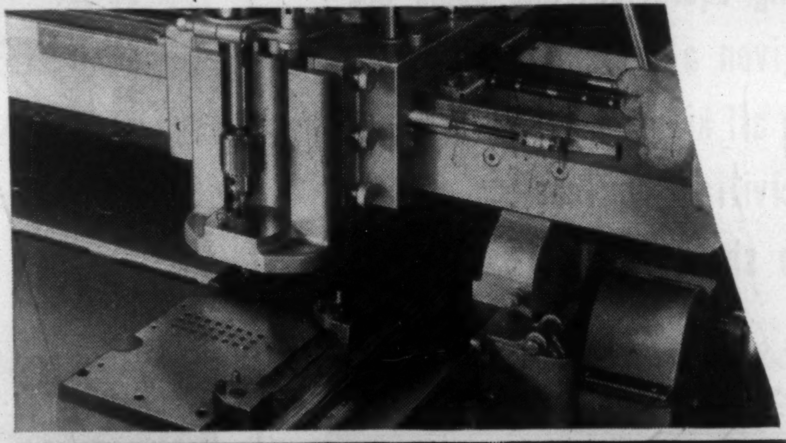
George F. Wales, *Chairman*

399 Payne Avenue, North Tonawanda, N. Y.

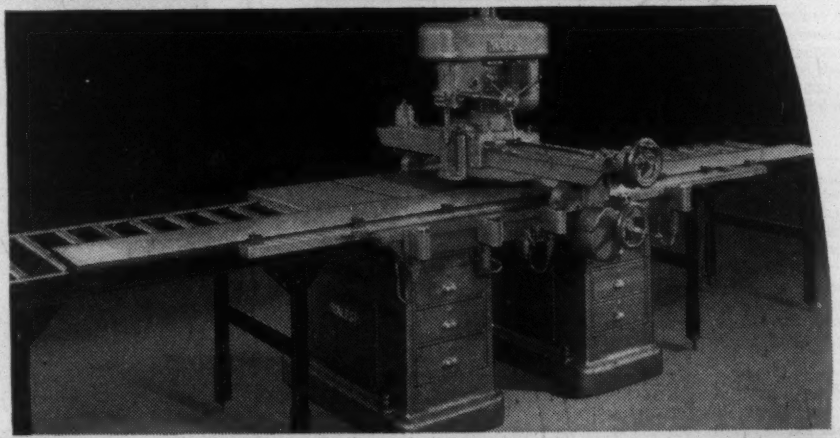
(Between Buffalo and Niagara Falls)

Wales-Strippit of Canada Ltd., Hamilton, Ontario

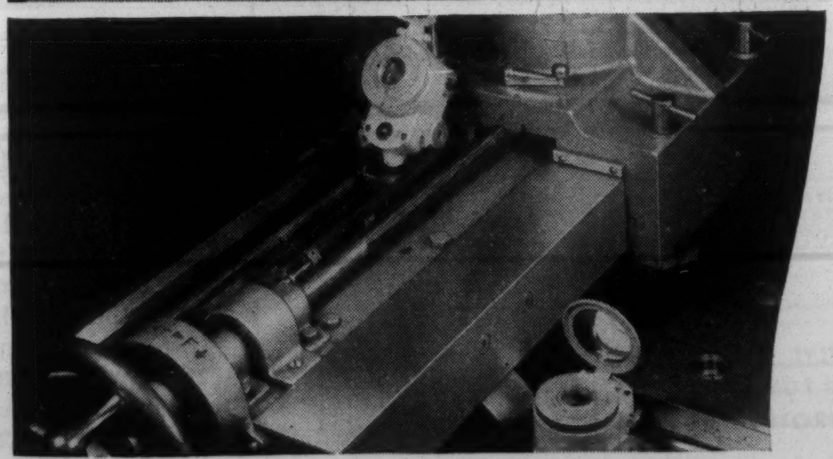
Specialists in Punching and Notching Equipment



Illustrating holes being accurately reamed in a small work piece.



Showing a Wales Extension Roller Table at each end of the Wales Drilling Machine. Note the long work piece that extends onto both extension tables from the machine table.



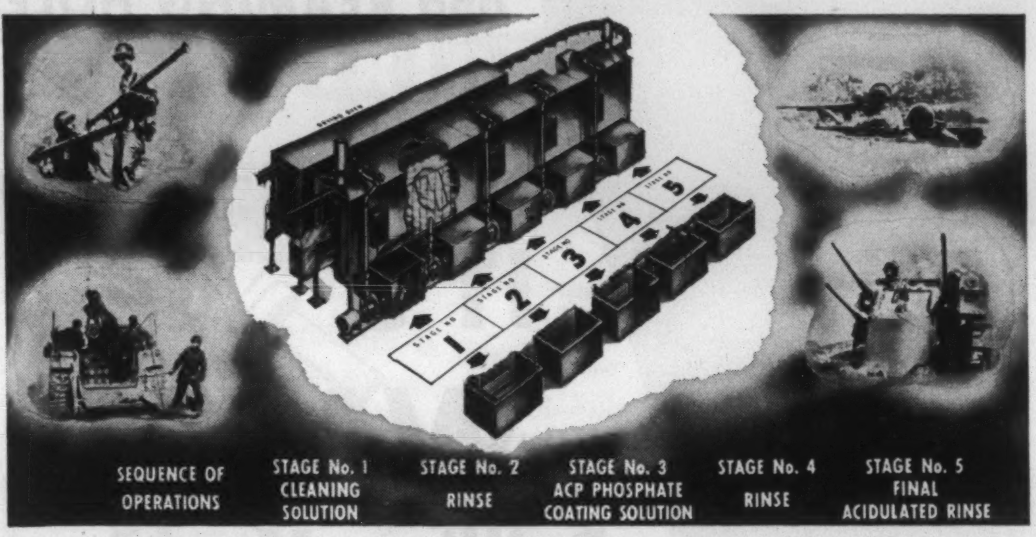
Showing "zeroing in" for precision accuracy by using precision optical gages.

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: METAL PRESERVATION AND PAINT PROTECTION WITH ACP PHOSPHATE COATING CHEMICALS


SEQUENCE OF OPERATIONS
STAGE No. 1 CLEANING SOLUTION
STAGE No. 2 RINSE
STAGE No. 3 ACP PHOSPHATE COATING SOLUTION
STAGE No. 4 RINSE
STAGE No. 5 FINAL ACIDULATED RINSE
1
2
3
4
5

U.S. ARMY PHOTOGRAPHS COURTESY OF "ORDNANCE MAGAZINE"

Typical spray and dip phosphating equipment and some ordnance products that are now given a protective phosphate coating for extra durability under all kinds of severe exposure conditions. Both military and civilian applications of ACP phosphate coating chemicals are shown in the chart below.

SELECTION CHART OF ACP PROTECTIVE COATING CHEMICALS FOR STEEL, ZINC, AND ALUMINUM

METAL	ACP CHEMICAL	OBJECT OF COATING	TYPICAL METAL PRODUCTS TREATED	GOVERNMENT SPECIFICATIONS
STEEL	"GRANODINE" Zinc Phosphate Coating Chemical	Improved paint adhesion	Steel, iron, or zinc fabricated units or components, automobile bodies, refrigerators, washing machines, cabinets, etc.; projectiles, rockets, bombs, rifles, small arms, belt links, cartridge tanks, vehicular sheet metal, tank bolts and links, recoilless guns, etc.	MIL-S-5002 JAN-C-490, Grade 1 JAN-F-495 U.S.A. 57-0-2, Type II, Class C U.S.A. 51-70-1, Finish 22.02, Class C U.S.A. 50-60-1 16 E4 (Ships)
	"PERMADINE" Zinc Phosphate Coating Chemical	Rust and corrosion prevention	Nuts, bolts, screws, hardware items, tools, guns, cartridge clips, fire control instruments, metallic belt links, steel aircraft parts, certain steel projectiles and many other components.	MIL-C-16232 U.S.A. 57-0-2, Type II, Class B U.S.A. 51-70-1, Finish 22.02, Class B Navy Aeronautical M-364 U.S.A. 72-53 (See An-F-20)
	"THERMOIL-GRANODINE" Manganese-iron Phosphate Coating	Wear-resistance anti-galling, safe break-in of friction or rubbing parts. Rust proofing.	Friction surfaces such as pistons, piston rings, gears, cylinder liners, camshafts, tappets, crankshafts, rocker arms, etc. Small arms, weapon components. Hardware items, etc.	MIL-C-16232 U.S.A. 57-0-2, Type II, Class A U.S.A. 51-70-1, Finish 22.02 Class A Navy Aeronautical M-364 U.S.A. 72-53 (See AN-F-20)
	"GRANODRAW" Zinc-iron Phosphate Coating	Improved drawing, extrusion, and cold forming	Blanks and shells for cold forming, heavy stampings; tubs; tubing for forming or drawing; wire; rod; etc.	———
ALUMINUM	"ALODINE" Protective Coating	Improved paint adhesion and corrosion resistance	Aluminum products of similar design such as refrigerator parts, wall tile, signs, washing machine tubs, etc; aircraft and aircraft parts; bazookas (rocket launchers), helmets, belt buckles, clothes dryers, clothesline, rocket motors, etc., aluminum strip or sheet stock.	MIL-C-5541 (See also QPL-5541-1) MIL-S-5002 AN-F-20 U.S. Navord O.S. 675 16 E4 (Ships) AN-C-170 (See MIL-C-5541) U.S.A. 72-53 (See AN-F-20)
ZINC	"LITHOFORM" Zinc Phosphate Coating Chemical	Improved paint adhesion	Zinc alloy die castings; zinc or cadmium plated sheet or components; hot dip galvanized stock; galvanneal; signs; siding; roofing; galvanized truck bodies; etc.	QQ-P-416 RR-C-82 JAN-F-495 AN-F-20 U.S.N. Appendix 6 U.S.A. 72-53 (See AN-F-20)

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDERS ON THE ABOVE CHEMICALS AND FOR INFORMATION ON YOUR OWN METAL PROTECTION PROBLEMS

CHEMICALS ACP PROCESSES

New Materials and Equipment

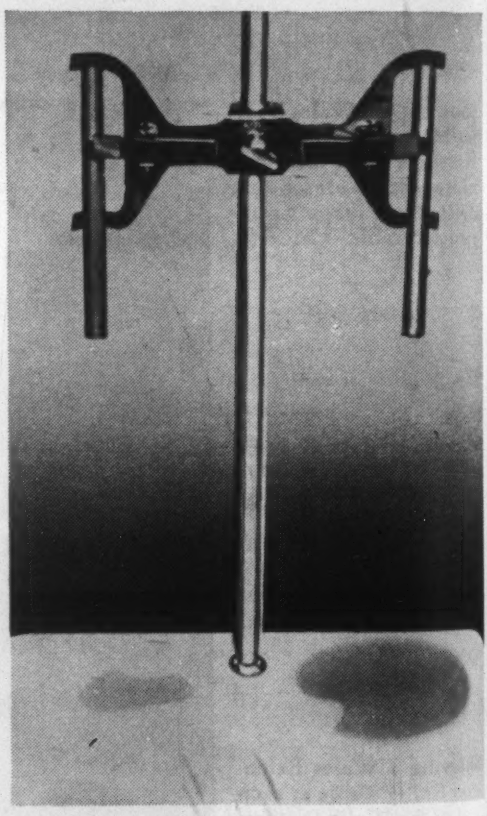
characteristics; high abrasion resistance; long life because of the reinforced fiber structure and the sealing qualities of the impregnant.

At the present time, supply of the packings is limited. Two styles are available—V's and Cup packings—produced in standard sizes. Only DO orders can be filled.

Phosphatizing Compound Produces Oil-Retaining Rustproof Surface

Iron and steel parts can now get two-fold protection with a chemical treatment offered by *Octagon Process, Inc.,* 15 Bank St., Staten Island 1, N. Y.

Known as Rustshield 2, the new product is a phosphatizing compound which is said to change steel and iron surfaces to rustproof, highly absorbent nonmetallic areas.



The piece of steel rod at left was treated with Rustshield 2 and then 5 cc of oil was poured over the top. Note the difference in size of oil spots. The rod at right was not treated.

A simple inexpensive immersion process, which consists of precleaning with vapor degreaser, safety solvent, or an alkali cleaner and then rinsing, rustshielding, rinsing and treating with a passivating agent, the compound meets the requirements for phosphate coatings in the U. S. Army Ordnance Specification 57-0-2C, Type II, Class A. The new finishes are said to be preferred to oxide coatings for many ordnance components.

The Steel that took the cussing out of changing an "Alligator's" Teeth

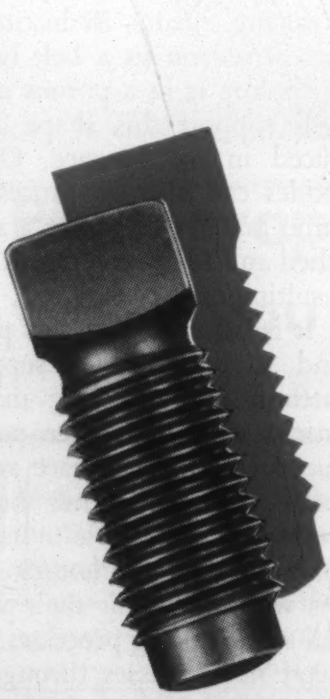
● Deep in the coal mines, mechanics had the knuckle-busting job of loosening the worn set-screws that hold coal-cutting bits in the endless chain of mechanical coal-mining machines . . . or "alligators". The grinding abrasion of coal and rock quickly wore off the square heads to round heads.

The Bowdil Company makes most of the cutter chains used on leading makes of coal-mining machines. They asked Republic Steel for a solution to the problem of the round heads on the "alligator".

A Republic Field Metallurgist recommended that Bowdil switch to a Republic *Carbon-corrected* Cold Drawn Alloy Steel Bar for the set-screws. They did . . . and there's been less cussing in the coal mines . . . plus a great reduction in the amount of high-priced time wasted in trying to get a grip on worn set-screws.

Carbon-correction produces long-wearing qualities in the square alloy steel bars right out to the corners . . . prevents the corners of the stock from turning up soft while the center has the desired hardness.

May we tell you more about Republic *Carbon-corrected* Cold Drawn Alloy Steels? And how Republic Three-Dimension Metallurgical Service helps manufacturers work these steels into their production? A letter will bring the Republic Field Metallurgist to call.



Republic Carbon-corrected Cold Drawn Alloy Steels make the square heads of these set-screws tough right out to the corners to withstand wear longer without rounding off.

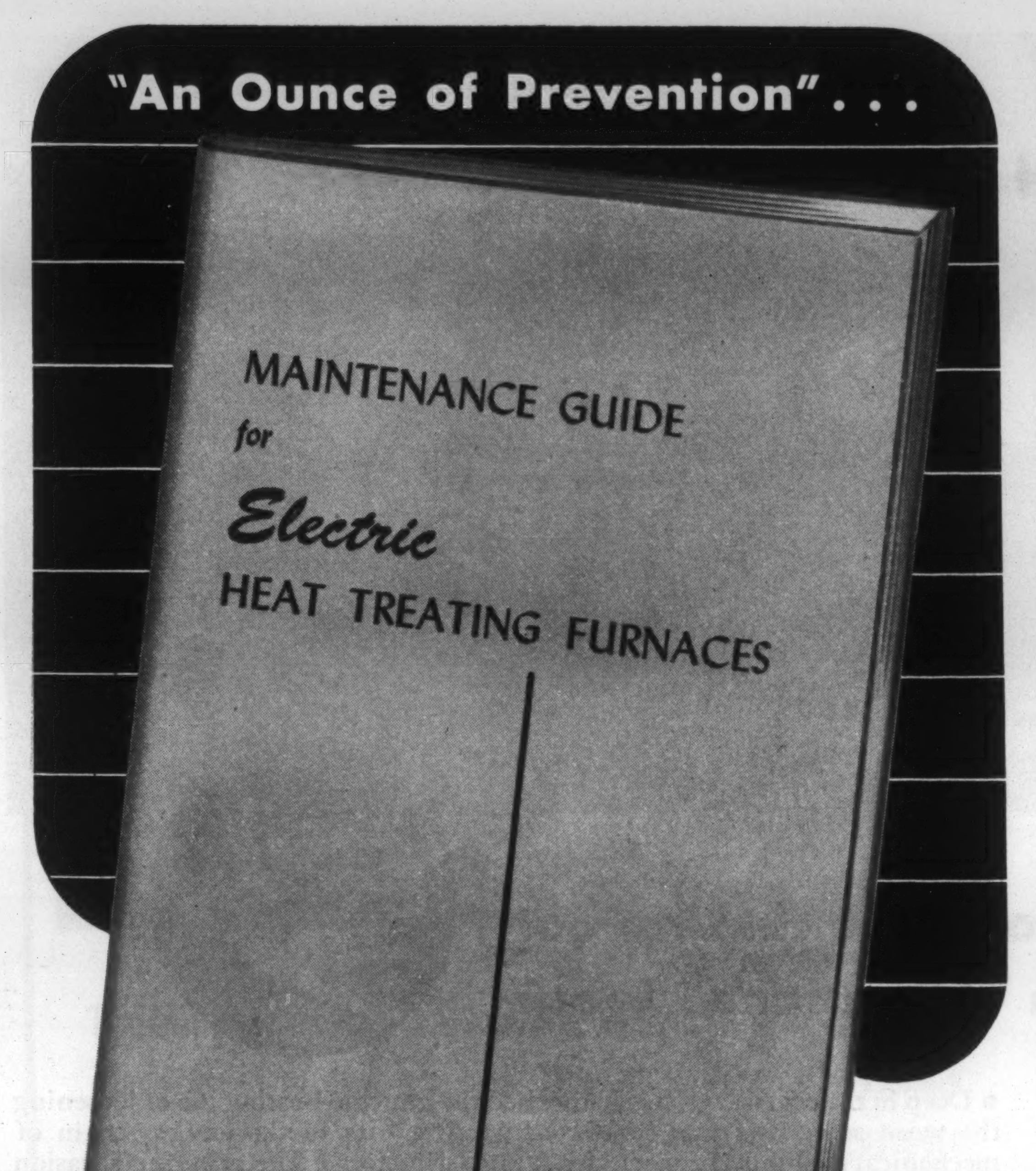
REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

REPUBLIC STEEL

Republic
ALLOY STEELS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

"An Ounce of Prevention" . . .



To Help
You Establish
a Preventative
Maintenance
Program

A periodic inspection of each part of your electric furnace is a most important factor in saving man hours and lost production caused by unscheduled shutdowns. Here is a brief, easy-to-read guide that describes each step to be taken in a preventative maintenance program. It is yours for the asking . . . "an ounce of prevention" that may avoid serious trouble in your heat treating department.

Send for FREE Copy Today!

HEVI DUTY®

HEVI DUTY ELECTRIC COMPANY

MILWAUKEE 1, WISCONSIN

Heat Treating Furnaces . . . Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

News Digest

continued from page 13

terial also takes an excellent porcelain enamel coating with no preparation or undercoating. It will bond, during manufacture, to steel, refractories and abrasive materials. At the very low densities, wood screws can be driven into by hand and it can be cut and worked with ordinary wood working tools. The cost of light steel parts compares with the cost of the same part made of malleable iron.

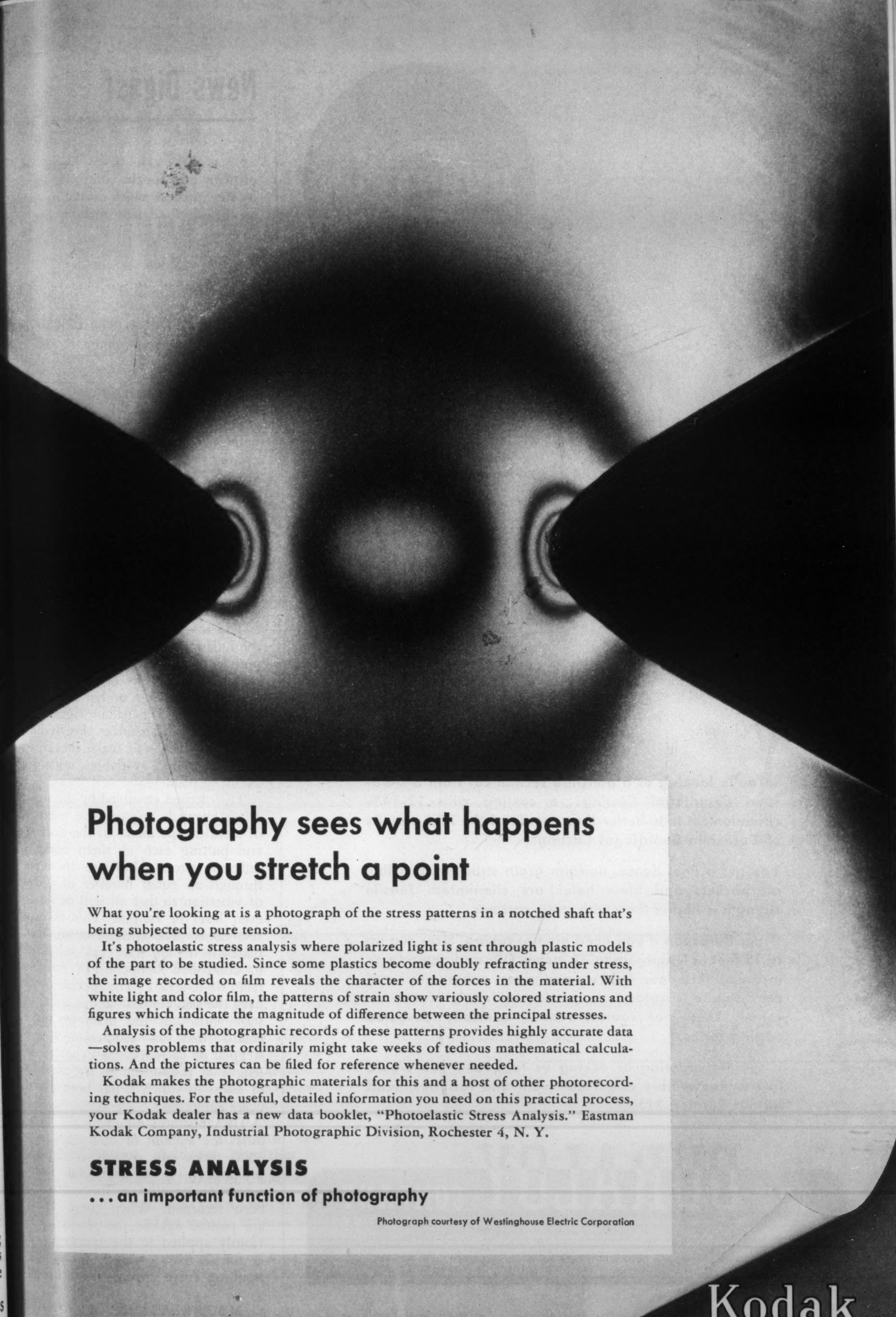
Reduction Process

Work started on this process in May 1951. The laboratory phase of the investigation has been completed, and an exploratory pilot run is now under way in an electrically heated tunnel kiln 65 ft long. The purpose of this first phase of the pilot operation is to explore the possible applications of the process. The next stage will be to get accurate production rates and costs.

It will be readily understood that other methods of reduction are quite practical. For example, extruded bars of iron oxide can be reduced in hydrogen or other reducing gases. If a very low carbon content is desired, hydrogen is, of course, the preferred reducing agent. Reduction can also be carried on in a belt type furnace if the ore is in a porous mold which will support this shape as it is reduced in the furnace. Other metal oxides can also be processed in the same manner to produce shapes, finished and semi-finished articles of the resulting metal.

It is believed that this process will find a place as a supplementary method of producing many useful articles of steel. When parts as produced from the furnace are used directly without further hot or cold working it is possible to use iron ores containing large amounts of impurities which prohibit their use in normal steel making processes. Since the metal never passes through a liquid stage, it is only necessary to keep such impurities as silica down to an acceptable level for the end use of the article.

In the case of such impurities as sulfur, phosphorus, titanium, nickel and chromium, the allowable limits of these elements will be determined by the required mechanical properties of the finished article and not by their deleterious effect on the hot working properties of the steel. These facts make it possible to consider the use



Photography sees what happens when you stretch a point

What you're looking at is a photograph of the stress patterns in a notched shaft that's being subjected to pure tension.

It's photoelastic stress analysis where polarized light is sent through plastic models of the part to be studied. Since some plastics become doubly refracting under stress, the image recorded on film reveals the character of the forces in the material. With white light and color film, the patterns of strain show variously colored striations and figures which indicate the magnitude of difference between the principal stresses.

Analysis of the photographic records of these patterns provides highly accurate data—solves problems that ordinarily might take weeks of tedious mathematical calculations. And the pictures can be filed for reference whenever needed.

Kodak makes the photographic materials for this and a host of other photorecording techniques. For the useful, detailed information you need on this practical process, your Kodak dealer has a new data booklet, "Photoelastic Stress Analysis." Eastman Kodak Company, Industrial Photographic Division, Rochester 4, N. Y.

STRESS ANALYSIS

. . . an important function of photography

Photograph courtesy of Westinghouse Electric Corporation

Kodak
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of many ores for the controlled density steel process which cannot be used in the standard steel-making operations.

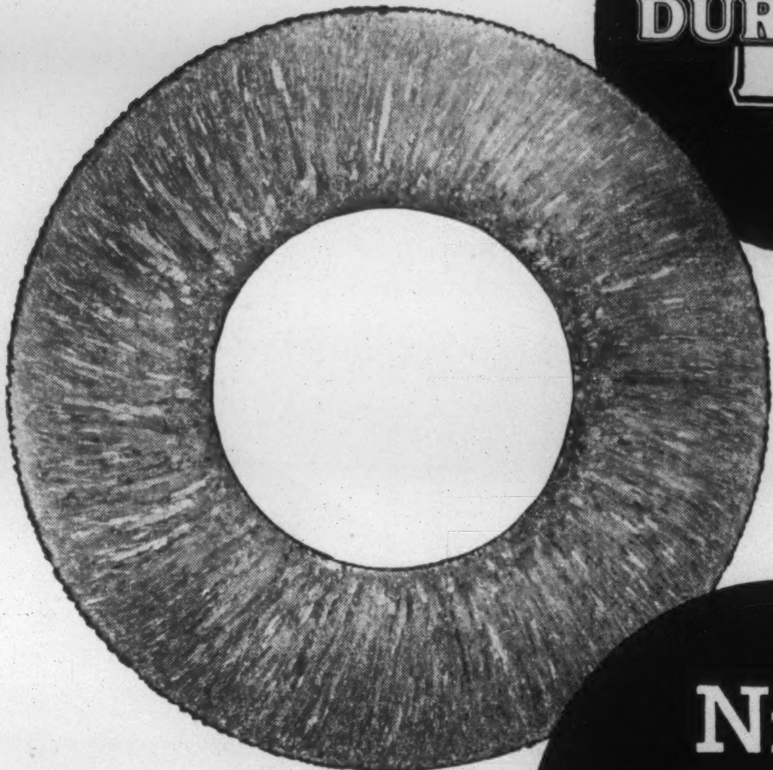
Endurance Limits Found Quickly by New Method

Two scientists at Rensselaer Polytechnic Institute have found a rapid and accurate way for testing steel alloys, other metals and plastics to find out how long they will stand up under fatigue loads when they are used for making moving parts of machines. The apparatus, which Dr. Joseph L. Rosenholtz and Professor Dudley T. Smith have assembled in their laboratory, makes possible the completion in 10 hr or less of a testing job which has been requiring 3 months or longer on costly machines under expert supervision.

The inventors call their discovery the Dilastrain Method. It is based on precise measurements of the extent to which specimens of a given material will expand under controlled temperatures. The patent rights will be held by Rensselaer Polytechnic Institute which will make the Dilastrain Method available under a licensing plan.

The method envolved by the Rensselaer scientists requires the selection of identical specimens of the material and putting each of them under a different stress. They are then put through an equal number of cycles of vibration so that all will be on an even level of fatigue. This takes a few hours. The specimens are then placed in the apparatus and subjected to controlled temperatures ranging from 68 to 212 F. The specimens all have the same length, about 2 in., to start with, but the inventors have found that as temperatures are stepped up each specimen changes in length in proportion to the amount of stress to which it has been previously subjected.

The apparatus automatically magnifies the amount of each expansion 3500 times and records it. In approximately 2 hr the total linear expansion of all test specimens has been recorded. When these values are plotted against the stresses previously applied to the specimens, it is found that a sharp dip in the resulting curve appears at the point



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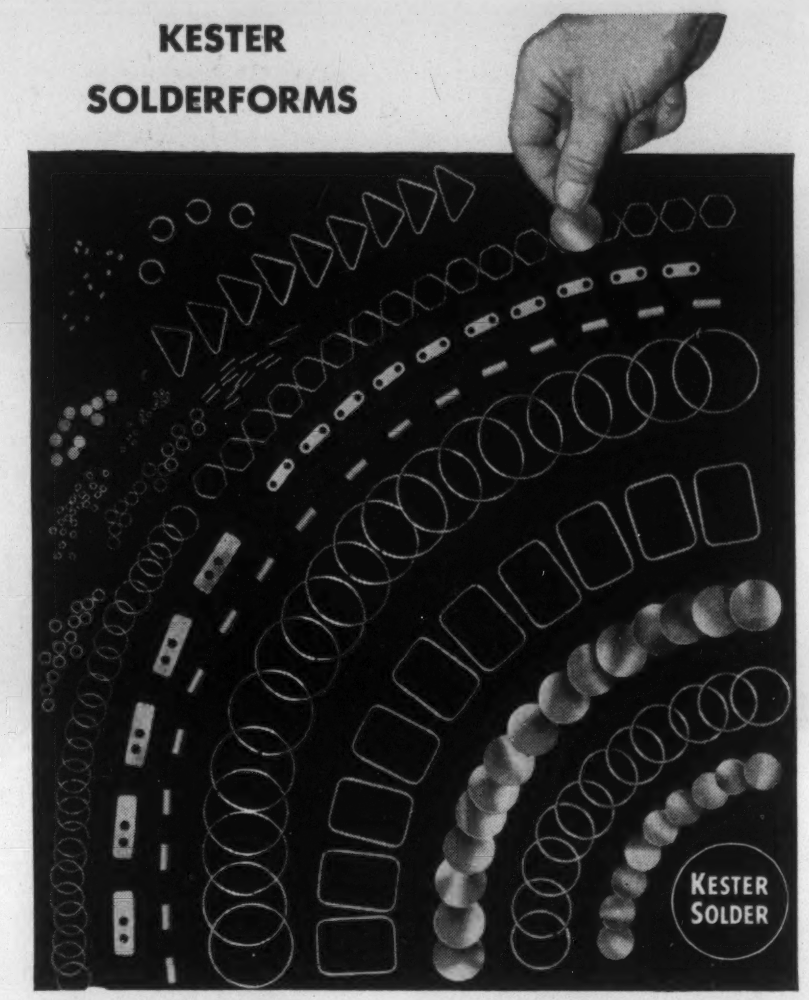

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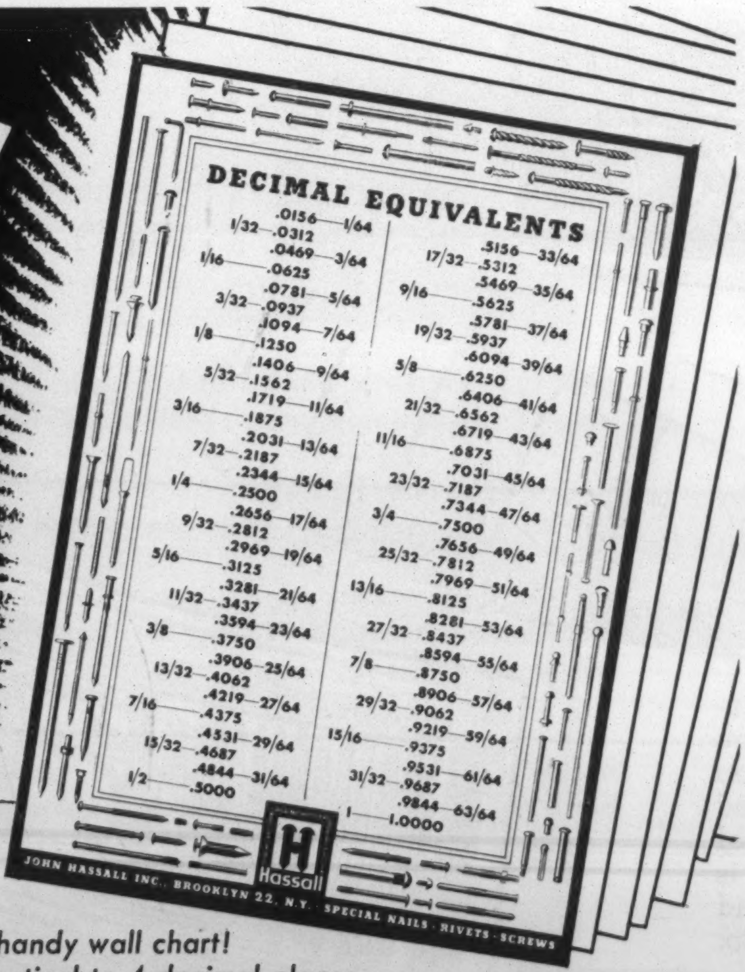

DECIMAL EQUIVALENTS

	.0156	1/64
1/32	.0312	
	.0469	3/64
1/16	.0625	
	.0781	5/64
3/32	.0937	
	.1094	7/64
1/8	.1250	
	.1406	9/64
5/32	.1562	
	.1719	11/64
3/16	.1875	
	.2031	13/64
7/32	.2187	
	.2344	15/64
1/4	.2500	
	.2656	17/64
9/32	.2812	
	.2969	19/64
5/16	.3125	
	.3281	21/64
11/32	.3437	
	.3594	23/64
3/8	.3750	
	.3906	25/64
13/32	.4062	
	.4219	27/64
7/16	.4375	
	.4531	29/64
15/32	.4687	
	.4844	31/64
1/2	.5000	
	.5156	33/64
17/32	.5312	
	.5469	35/64
9/16	.5625	
	.5781	37/64
19/32	.5937	
	.6094	39/64
5/8	.6250	
	.6406	41/64
21/32	.6562	
	.6719	43/64
11/16	.6875	
	.7031	45/64
23/32	.7187	
	.7344	47/64
3/4	.7500	
	.7656	49/64
25/32	.7812	
	.7969	51/64
13/16	.8125	
	.8281	53/64
27/32	.8437	
	.8594	55/64
7/8	.8750	
	.8906	57/64
29/32	.9062	
	.9219	59/64
15/16	.9375	
	.9531	61/64
31/32	.9687	
	.9844	63/64
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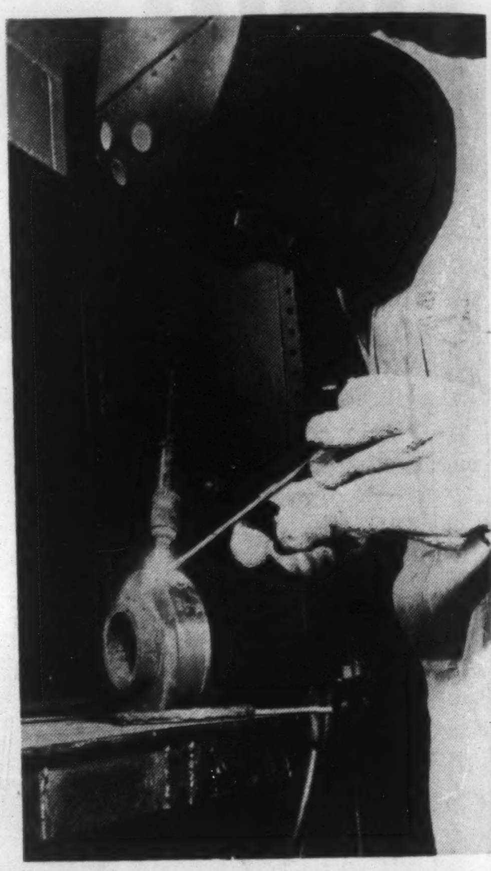
News Digest

where the test material reaches its endurance limit.

Tests have already been run on a steel alloy supplied by the Allegheny Ludlum Steel Corp., and the endurance limit which was found is admittedly more accurate than that found by ordinary methods.



G-E announces that it may be possible to lay down a thin layer of extremely hard tungsten carbide on metal surfaces by hard-facing methods. Laboratory-developed rod for conventional arc-welding equipment deposits 70% tungsten carbide. The coating has 80% of the wear resistance of tungsten carbide prepared as a cemented compact.

Three-Dimensional Photoelastic Stress Analysis Method Announced

A new method of three-dimensional photoelastic stress analysis has been developed by Dr. Max M. Frocht, research professor and director of experimental stress analysis at the Illinois Institute of Technology, and Roscoe Guernsey, associate professor at the University of Texas, formerly a research fellow at Illinois Tech. With the new method it is now

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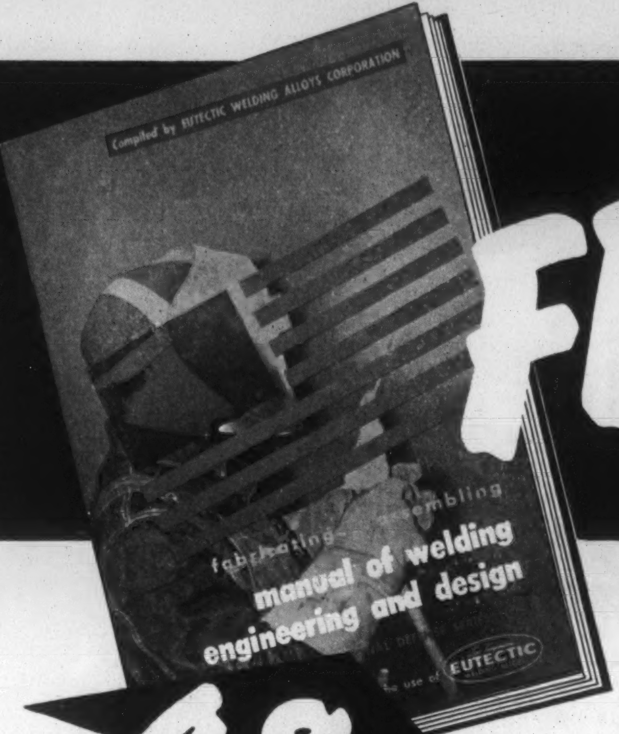
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possible to determine the actual principal stresses at any interior point of a body. Prior to this development, only principal shears could be found.

In making such a study, Dr. Frocht first machines a plastic model of the part to be analyzed. This is then placed in a special furnace designed for this purpose. The loads are applied while the plastic model is heated to a suitable high temperature and are not removed until after the model cools to room temperature. The stresses developed by the loads are in this way frozen into the model. The model can then be sliced or sectioned without disturbing the frozen stresses. These sections, when placed in a photoelastic polariscope, reveal a stress pattern which can be observed and photographed.

The stresses present at any point in a section can be studied in detail and the complete stress system, consisting of maximum, minimum and intermediate stresses, can be found.

Methods previously proposed required special materials not available in this country. The present method is effective with available materials such as Fosterite. Previous methods were limited to the elastic state. The new method applies to both plastic and elastic stresses in the model. The new method has been applied to a specific problem with a great deal of accuracy. The method makes it possible to study three-dimensional stresses in complicated machine parts and structural elements which had hitherto defied both theoretical and experimental analysis.

Dr. Frocht and Guernsey were assisted in the development of this method by David Landsberg, assistant research engineer in the photoelasticity laboratory at Illinois Tech. A paper giving the theory of the method was presented before the first U. S. National Congress for Applied Mechanics last June in Chicago. The development grew out of an investigation sponsored by the National Advisory Committee for Aeronautics and the Research Corp.

Single-Track Light Sources

While some lamp designers are busy creating light sources with more complete spectrums, a few others are doing exactly the opposite. They are

Plastics NEWS

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Here's a case where the inherent resilience of shock-resistant General Electric rubber-phenolic compounds helped to lower scrap losses.

When a conventional flock-filled phenolic was used, riveting the metal side screens onto the plastics eyecups of these safety goggles resulted in considerable breakage. By a simple switch to G-E rubber-phenolics—and using the same molds—these losses were made negligible. In addition, goggles are being produced which provide longer-lasting service under rough usage.

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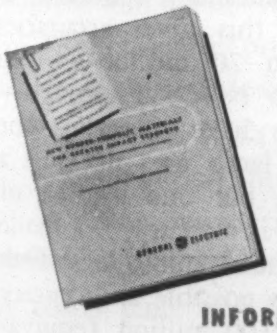

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trying to create lamps with all the visible light crowded into a single sharply-defined line of the spectrum, *i.e.,* monochromatic light. Most of these special line-output lamps are used in research laboratories as a light source for spectroscopy.

Each element of nature, when caused to give off light by the passage of electricity through it in the vapor state, produces visible or invisible radiation at a few specific frequencies or spectral lines. These are as unique to that element as fingerprints to an individual. They are immutable and easily reproducible, and hence, extremely useful for reference, for measurement, or for identification of unknown substances.

Many such lamps are being produced in small quantities. These include several metals, such as sodium, potassium, cesium, cadmium, zinc and mercury, and some of the rare gases, as xenon, krypton, argon and neon. Structurally, they are quite similar. A small amount of the metal or rare gas, in extremely pure form, is contained in an arc tube with electrodes. This is surrounded by an outer glass housing, evacuated to conserve heat.

One of the most interesting applications of one of these lamps is as a new standard of length. Since Michelson's work in measuring the standard meter bar in Paris, the red line of cadmium (6438 Angstroms) has been the international standard of length. While this gives accuracies of one part in 20 million—which would seem to be good enough—lamp engineers have recently done better. A new lamp uses not just a single element, but one isotope of that element. It is mercury 198, made from gold in the atomic pile at Oak Ridge. It makes possible an accuracy of one part in 100 million (equivalent to 1 ft in the circumference of the earth). The mercury 198 lamp is better in other ways. Its dominant line is green (5461 Angstroms), which coincides with the maximum sensitivity of the eye and operates at normal room temperature.

Cesium lamps have enjoyed a dramatic task outside spectographic work. Cesium delivers almost all of its light in a few sharp lines in the infra red. Only a weak, peach-colored glow is visible from a cesium lamp. Such lamp outputs, modulated by voice signals, made communication possible during the last war without detection by the enemy.

Cadmium lamps are being used in

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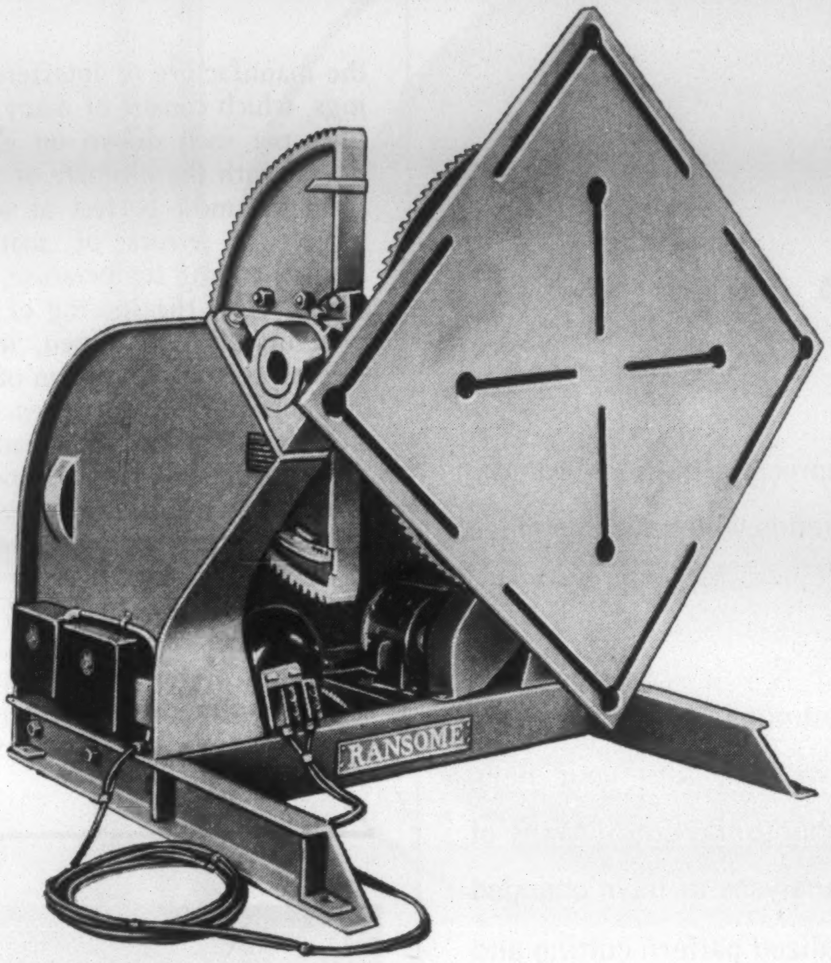

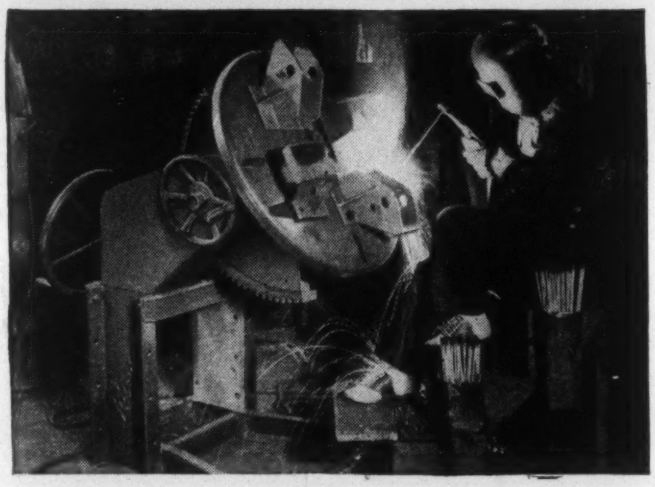

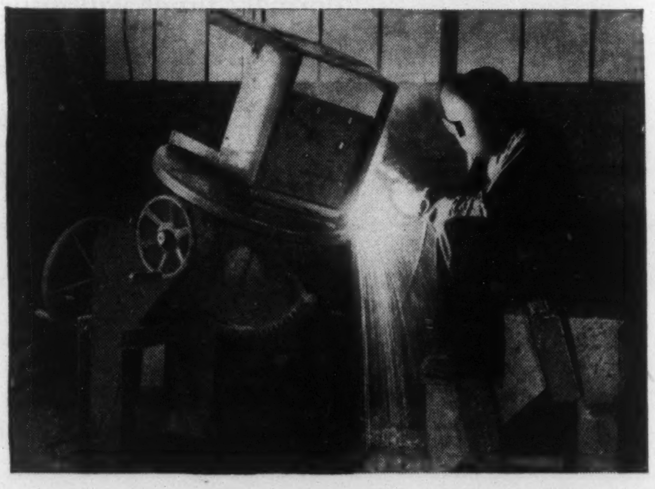

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the manufacture of interference gratings, which consist of many thousand lines per inch drawn on glass—and drawn with the ultimate of precision. Even the most perfect of screws are subject to errors of manufacture, from changing temperature, or lubrication. Now the spacing of the lines is accurately determined, instead of by the precision operation of a screw, by counting the interference fringes from a special cadmium lamp.

These line-spectrum lamps are also being used in industry for analysis of substances that otherwise would have to be made chemically. For example, it is possible to determine with a sodium, mercury or cadmium lamp the exact origin of the sugar in a solution, whether it be from cane, beet, honey, or some other source.

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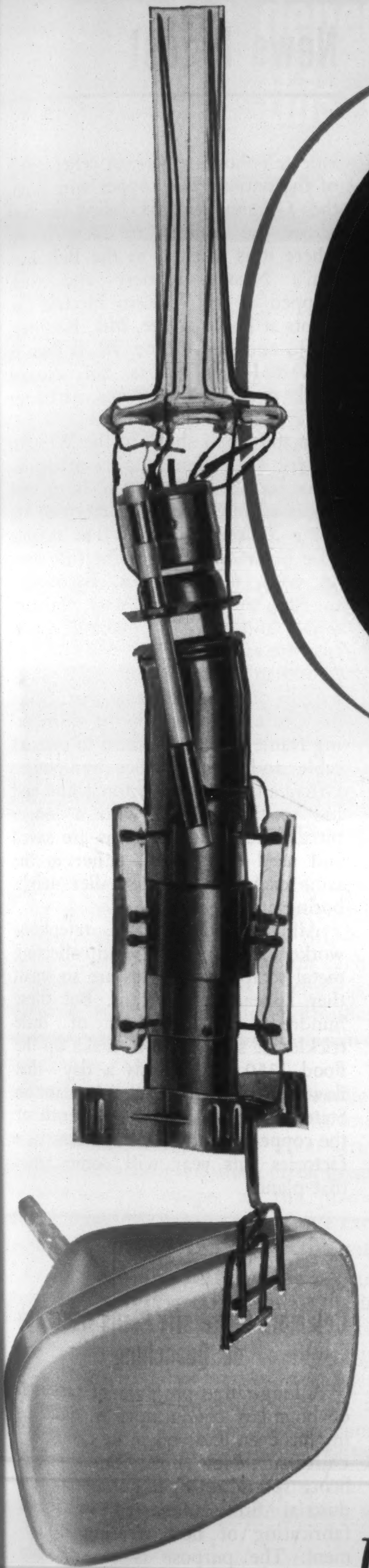
Bell's Conservation Drive Saves Copper and Other Critical Items

Conservations of materials has become one of the primary objectives of the Bell Telephone System.

For example, on Roberts Mountain in Oregon, linemen are taking down the "Old South Lead". Built in 1898, this bare copper wire line has carried long-distance calls for over 50 years. It is giving way to a stormproof underground coaxial cable. The hardware, wire, cross-arms and poles in good condition will be reused to pro-



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Latest development in picture tubes is the Du Mont Selfocus Teletron which provides *automatic focus at all times without the aid of external circuits or devices.* This eliminates the focusing coil or PM unit now used on standard electromagnetic-focus picture tubes, affording a substantial saving of vital materials in the manufacture of television receivers.

The Selfocus Teletron employs electrostatic focus with magnetic deflection, and this type of receiver is unique among electrostatic-focus tubes because its focusing element is operated at zero volts and is tied internally to the cathode through a resistor.

The elimination of focus circuits from the receiver is made possible largely by the focusing cylinder of the Selfocus picture tube. The unusual design of the cylinder and the precision with which it can be located in the electron gun produce increased picture quality by minimizing defects which have been inherent in conventional picture tubes. With greater control of these defects, it is possible to maintain quality uniformly from tube to tube.

Driver-Harris, who has been supplying Du Mont with alloys for cathode ray tubes for more than 10 years, supplies Stainless Steel 18-12 and special D-H Nickel No. 599 for manufacture into important parts of the electron gun of Du Mont's new Selfocus Teletron. The special requirements of this facet of the television industry are well served by the properties of these metals.

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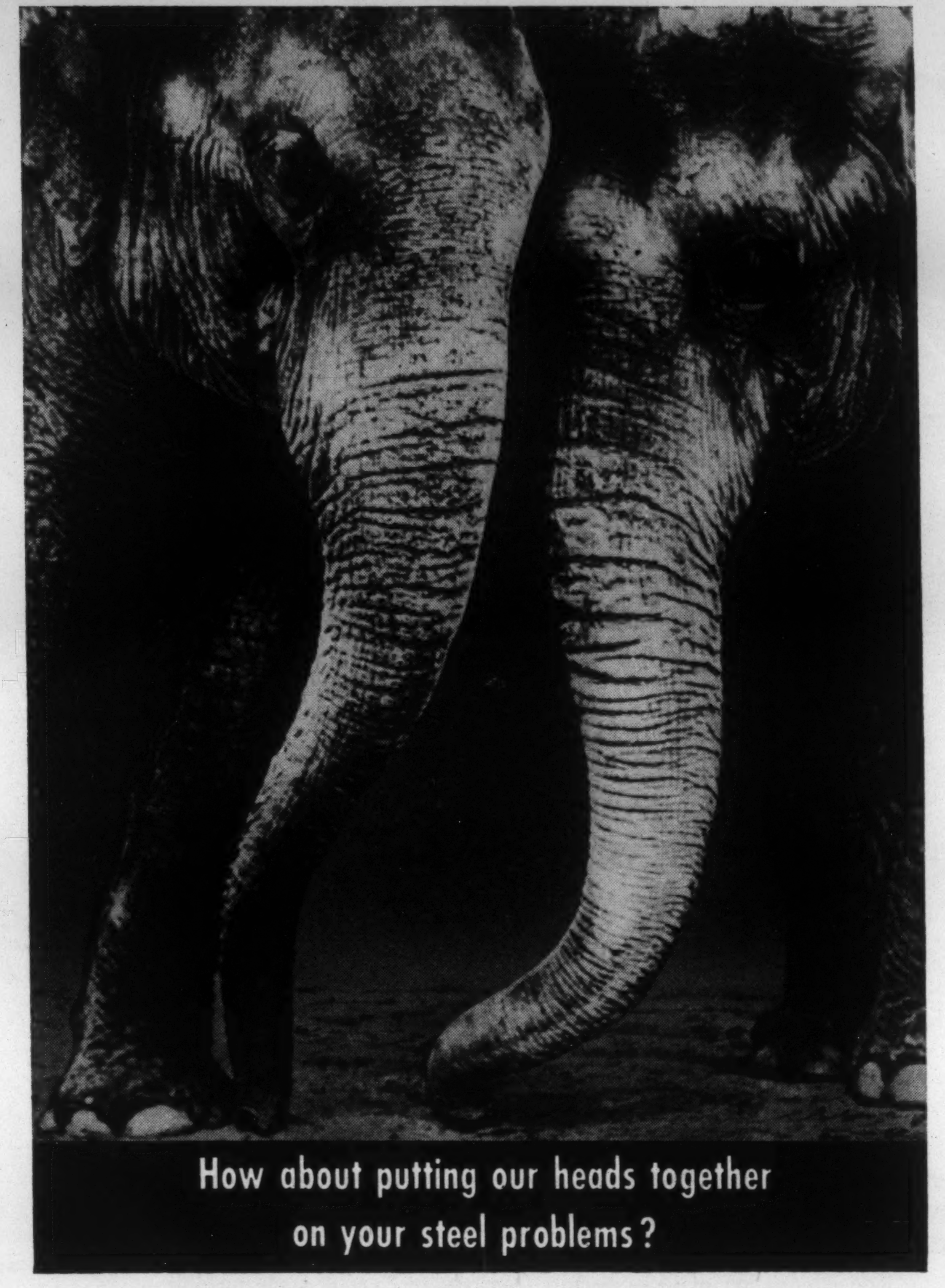

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vide telephone service in other parts of the nation. The copper wire from the Oregon line is being rushed across the country to New York, where it is smelted in the Bell System's Nassau refinery and then shipped to the Western Electric Co. plants at Point Breeze, Md., Kearney, N. J., and Hawthorne, Ill. It then is converted into parts for coaxial cables, radio relay systems, exchange cables and other equipment.

In the repair shops of the Western Electric Co., main supplier of equipment for the Bell System, burnt out pieces of low-melting point wire are being replaced in fuses. The fusible wire is the only part of the fuse used up when it blows out. By replacing this tiny piece of wire, the materials and work of making a new fuse are saved.

Exchange employes coil short lengths of reusable frame wire. Miles of wire are utilized in the distributing frame in central offices to connect cable and central office equipment. Often an old wire is too short and has to be replaced with a longer piece. These short lengths are saved and used over again, either in the same exchange or in smaller neighboring offices.

All over the country, telephone workers are recovering and collecting metal scrap. Most items are so small they appear insignificant. But these hundreds of thousands of little trickles of scrap help to make up the flood—350,000 pounds a day—that flows into Western Electric's plant on Staten Island. About one-seventh of the copper used by Western Electric's factories this year will come from that plant.

Columbia University Plans Research on Quenching

A long-range program of research on boundary conductance in quenching has been undertaken by Columbia University, New York. The work is being sponsored by a number of industrial firms interested in metal fabricating of heat treating equipment. The purpose is to correlate experimental results with derived values of boundary heat conductance for various body shapes in different quenching media. It is hoped that practical results will be obtained to

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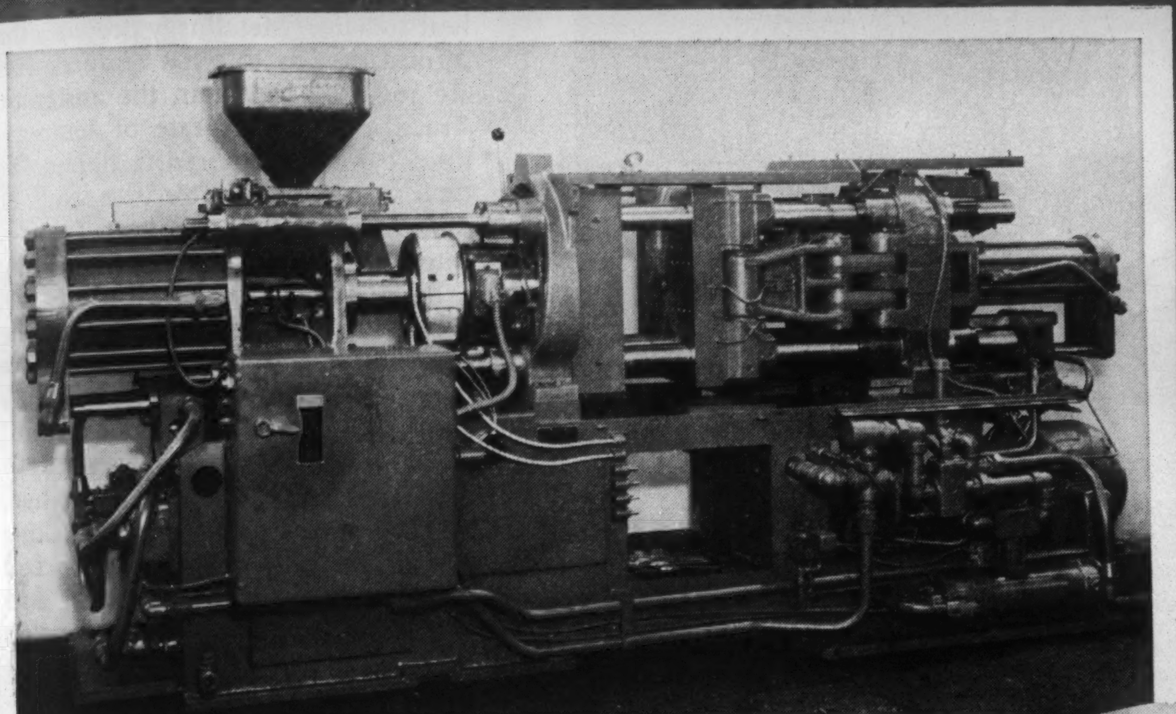

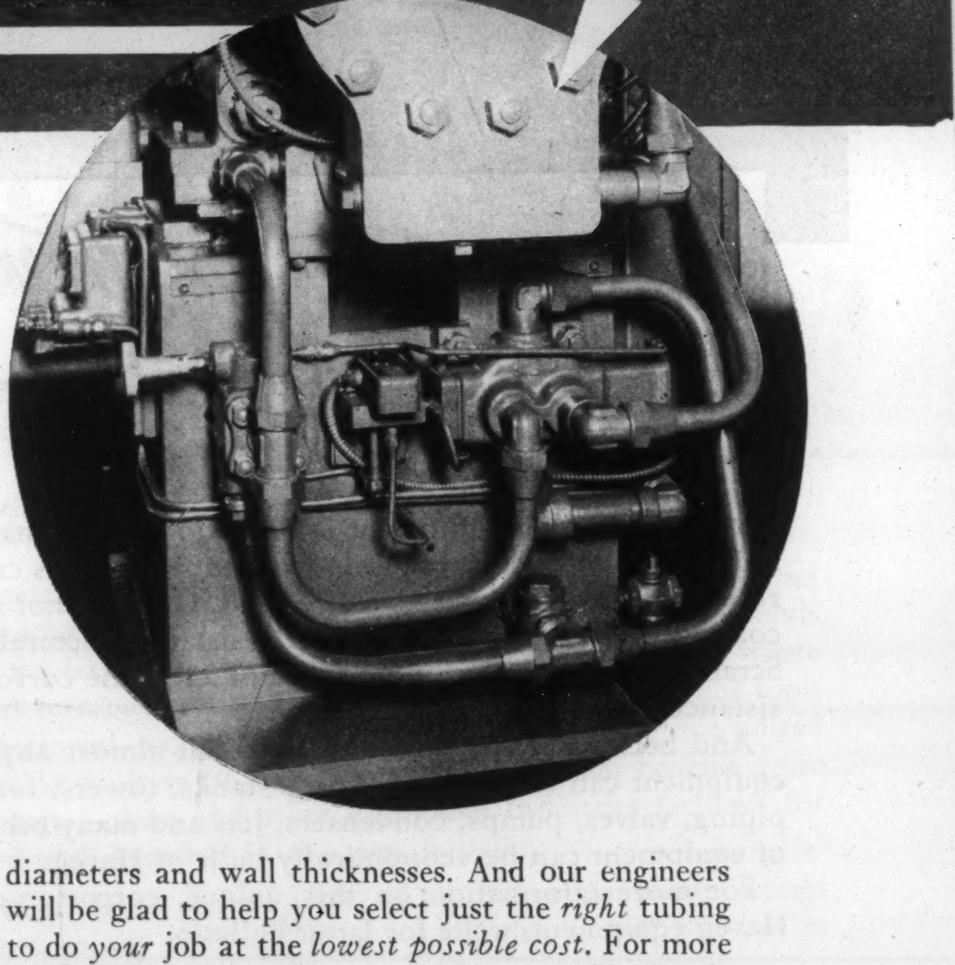

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*Name of manufacturer on request.

Today's plastic injection molding machines have to *produce*—day after day, often 'round the clock. The continuous duty 10D-8 shown here* exerts a 20,000 p.s.i. pressure on each 8-ounce shot of material. And since this machine is hydraulically operated, every part of the hydraulic system must be as near fool-proof as skilled design and materials engineering can make it.

The National Seamless Hydraulic Tubing used in this equipment has to meet some unusually severe requirements. It must have great strength to resist the high internal pressures (often greatly multiplied by momentary surges as the piston starts and stops). Also, the tubing must have excellent fatigue resistance to withstand destructive vibration.

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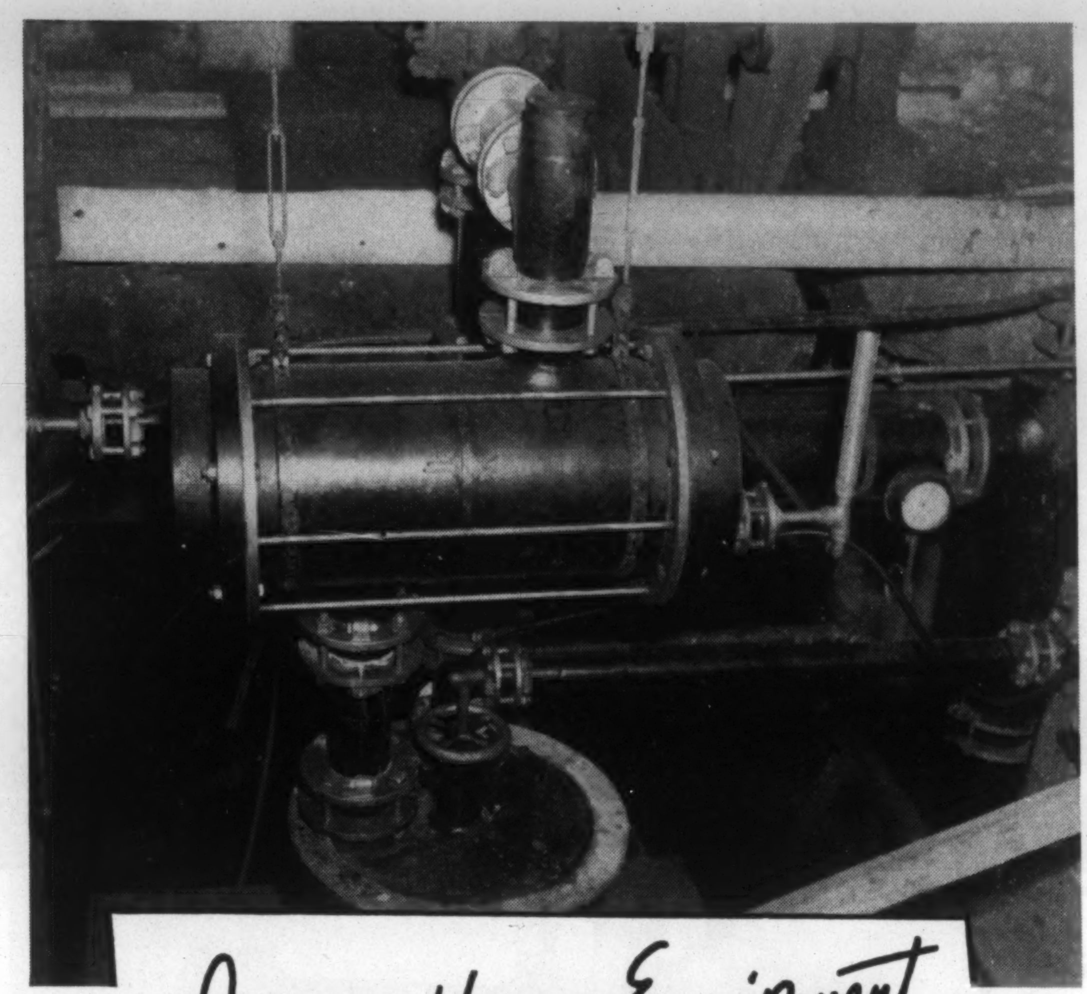

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take some of the guess-work out of commercial quenching.

Thus, the art of quenching and hardening is based on metallurgy and heat transfer. Metallurgy provides the information as to what temperatures are required to obtain the austenitic structure and what rate of temperature change is required to obtain the desired structure after the end of cooling. The field of heat transfer enters the picture because in cooling a body, temperature differences between surface and center occur. The temperature drop at the surface might or might not be sufficiently rapid to obtain the desired structure; the rapidity of its drop does not only depend on the quenching medium but also on the mass of steel backing the surface. But even if the surface cools at the desired rate, this does not imply automatically that points below the surface cool sufficiently rapidly to maintain the desired structure. The relationship of temperature changes at the surface and at various parts within the body is one of the subjects of the science of heat transfer as far as hardening is concerned.

It is, to date, extremely difficult if not impossible to relate data on hardenability to pieces of different shape; or to relate hardenability of a given steel in one quenching medium to that obtained in a different quenching medium. One reason for these difficulties of correlation may be seen in the lack of thermal studies in this field.

Thermally, the process of quenching involves the problem of heat conduction in the sample and that of convection from the surface of the sample to the quenching medium. Both problems are closely interrelated, and any practical case requires the solution of both. The main difficulty encountered in the solution is the lack of knowledge of thermal properties. Although information on the properties of steels are still scarce, they are much better established than the so called "boundary conductance" (Btu, sq ft, hr, F), which determines the cooling by convection, and expresses the rate of heat flow per unit surface area (Btu, sq ft, hr) for 1-deg temperature difference between surface of the sample and the quenching media. The boundary conductance will not only essentially determine the rate of temperature drop at the surface, but—possibly even more important—will influence critically the difference between rates of

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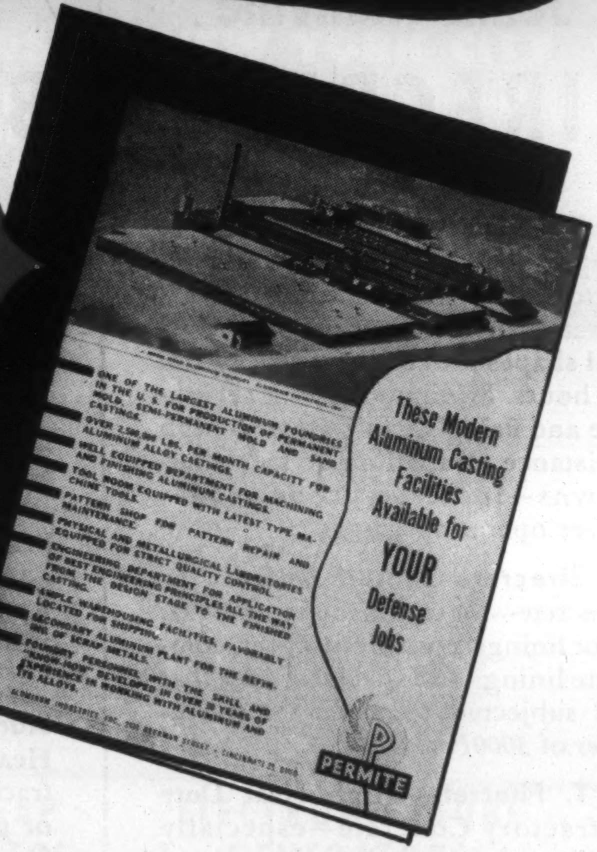

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temperature change at different points in the body.

The ultimate goal of the proposed work is to make it possible to predetermine accurately the correct heating and cooling cycle for quenching steel of any size and shape. It is believed that, in addition, this study will result in important theoretical insight. At present it is not possible to know the rates of temperature change within a body of any appreciable thickness during quenching. Direct temperature measurements by and large fail, except for high precision laboratory tests like those suggested for the present project; computations are not possible without a knowledge of the boundary conductance. The latter is, however, undoubtedly a function of size and shape, among other things.

Thus, studies made by observing thin samples and conclusions drawn from the mechanical properties observed on such thin samples are of limited importance only, because of the inability to correlate work on such thin samples with that on larger samples. The latter, even if heated to the same original temperature and quenched in the same quenching medium, will cool at a rate different from that of the small sample.

Thus, if the boundary conductance will be known from the present experiments, it will be possible to work with large samples and correlate the observed hardness at and below the surface with rates of temperature change at these points.

It is contemplated to use four quenching media at present:

1. A brine solution (which most nearly approaches the ideal quench).
2. Water
3. One light oil
4. One heavy oil

Initially, the work should be carried out with samples in the shape of a sphere. Later on cylinders should be included and, in the latter case, the influence of the angle under which the cylinder hits the quenching bath is one of the variables to consider. Artificial agitation of the quenching bath should enter the program.

The list of sponsoring concerns for the program include Ajax Electric Co., Inc., Philadelphia; Bell & Gossett Co., Morton Grove, Ill.; Caterpillar Tractor Co., Peoria, Ill., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; Ford Motor Co., Detroit; Gulf Research and Develop-

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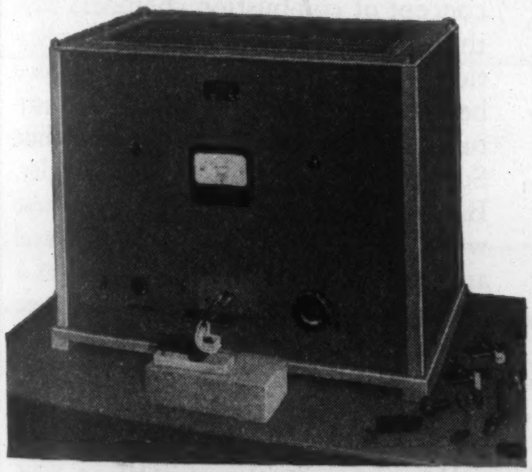

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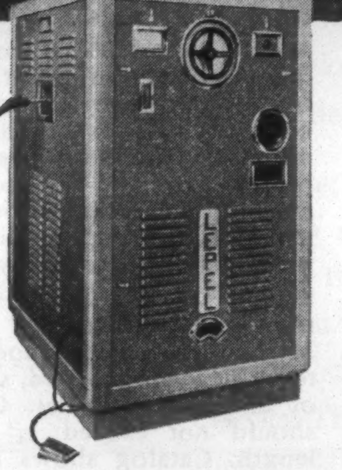

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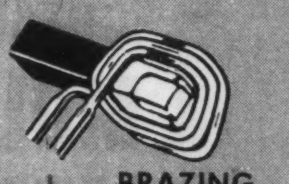

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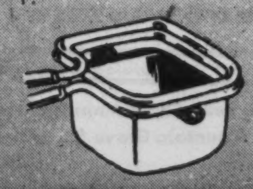

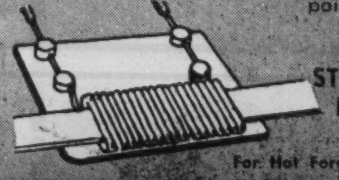

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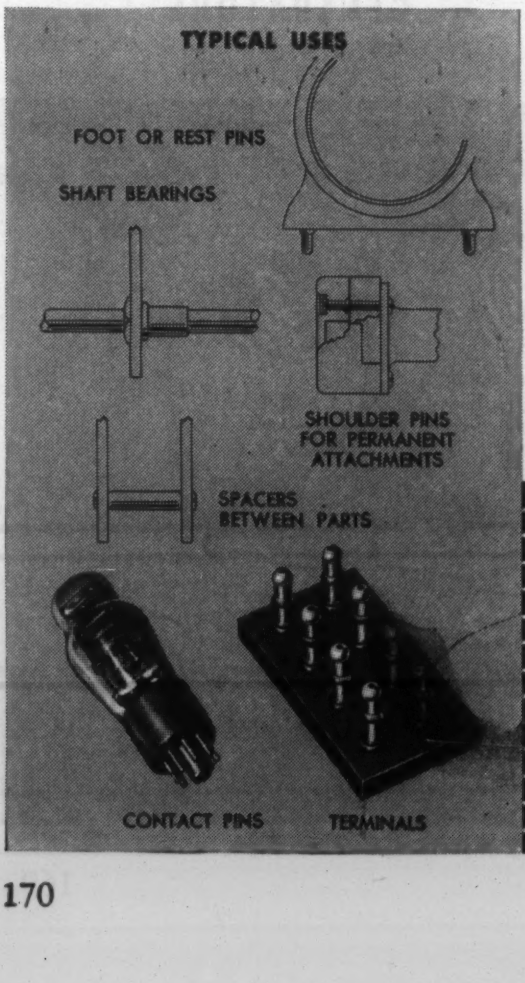

ment Co., Pittsburgh; Holcroft Corp., Detroit; Hughes Tool Co., Houston; Reed Roller Bit Co., Houston; W. S. Rockwell Co., Fairfield, Conn.; Surface Combustion Corp., Toledo; SKF Industries, Inc., Philadelphia; Timken Roller Bearing Co., Canton, Ohio; White Motor Co., Cleveland; and Engineering Foundation, New York.

- The Signal Corps thinks a ceramic, barium titanate, may replace vacuum tubes as amplifiers in electronic circuits. It has a high dielectric constant which varies with the applied a.c. voltage at high frequencies. Barium titanate also has electrical memory characteristics which make it useful in computers and television equipment.

Shipboard Applications of Porcelain Enamel Cited

A new honeycombed wall structure, noncorrosive tubing and a new concept of combustion chambers were three of the "landlubber" applications for porcelain enamel cited before the Porcelain Enamel Institute's 20th annual meeting at White Sulphur Springs by F. R. Nagley, Bureau of Ships, U. S. Navy. These were not revealed as actual Naval applications but ideas conceived as a result of marine research, and were offered for development by the industry.

The first suggested application was for a honeycombed structure which could serve as either a wall or floor panel. The panel consisted of a flat sheet on either side of a center which looked like the hexagonal pattern of a honeycomb in cross section but which was actually a sandwich of formed sheets in the center that combined to create a series of vertical columns. It was suggested that these could be formed and assembled using porcelain enamel not only as the protective coating but also as the adhesive in place of welding. He pointed out that this type of panel structure would offer a saving in total weight in comparison with

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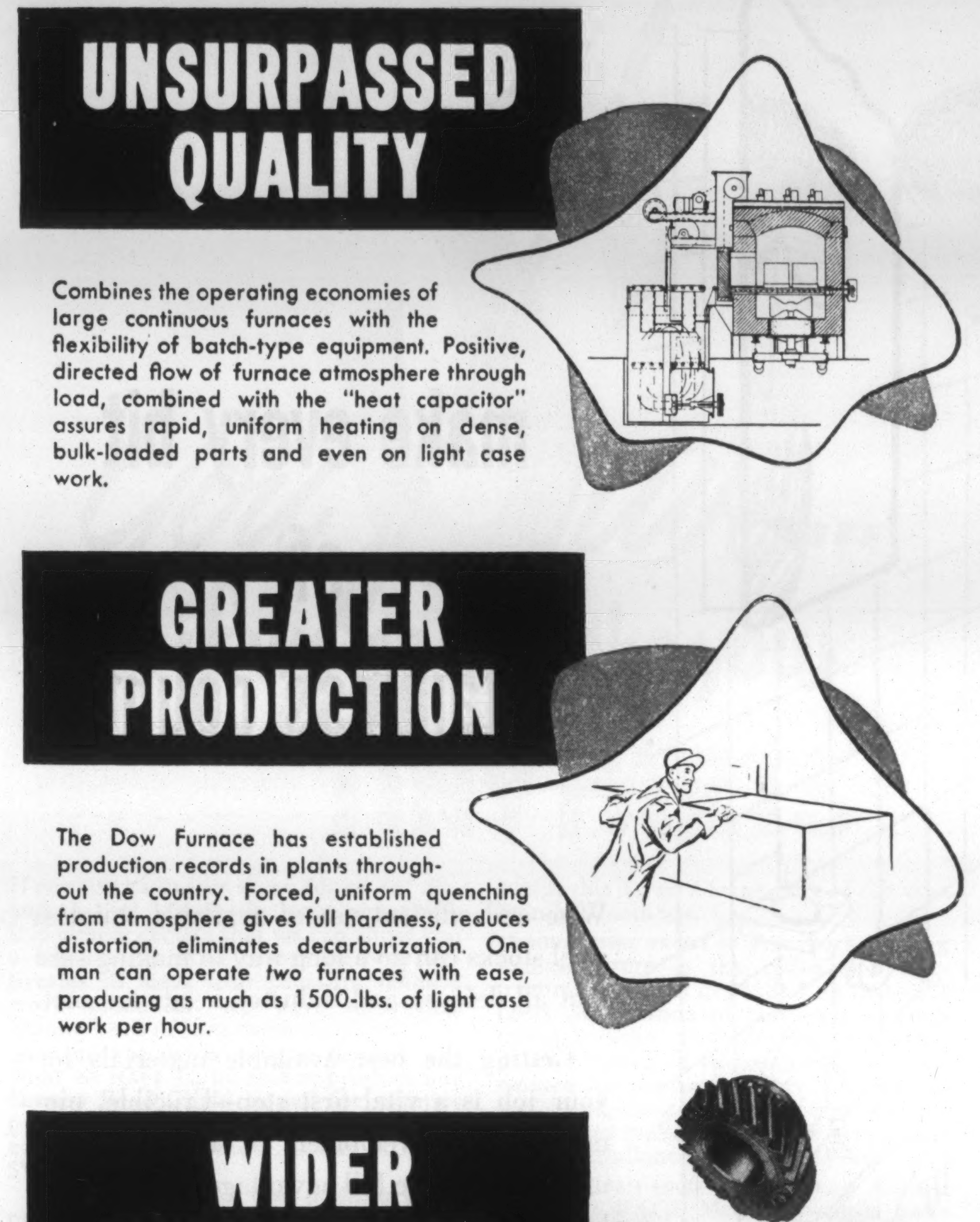

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flexural strength and that it was further strengthened by the application of porcelain enamel which increases rigidity. In either floor or wall applications this honeycombed structure would also offer excellent conduits for wiring or transmission of heat or air conditioning.

Mr. Nagley also illustrated the possibilities of porcelain enameled lightweight tubing, utilizing the porcelain enamel as a stiffening agent as well as a noncorrosive internal and external coating. Critical service conditions, such as high velocity sea water and the combination of the acidic condensate of exhausts and sea water experienced in marine service were pointed out as evidence of the practicability of such use of porcelain enamel.

A new concept of the coming nature of fuels was also described to emphasize the further possibilities for porcelain enamel in combustion chamber use. The new idea is one of highly concentrated fuels which will have increasingly high intensity per unit of measure. To obtain the efficiency of such fuels, it was pointed out that chemical inertness, a high degree of emissivity and extreme resistance to thermal shock and combustion products, such as offered by porcelain enamel, would be necessary.

- The Ferroxcube Corp. of America has published a booklet on the use of ferro-magnetic ferrites as magnetic cores in electronic and electrical circuits. Among the subjects discussed are the effects of copper, eddy currents, hysteresis and residual losses in magnetic materials as they pertain to inductor design.

NACA Publishes Research Abstracts

The National Advisory Committee for Aeronautics, Washington 25, D. C., has published several research abstracts of interest to materials engineers:

"Relative Structural Efficiencies of Flat Balsa-Core Sandwich and Stiffened-Panel Construction." Ralph E.

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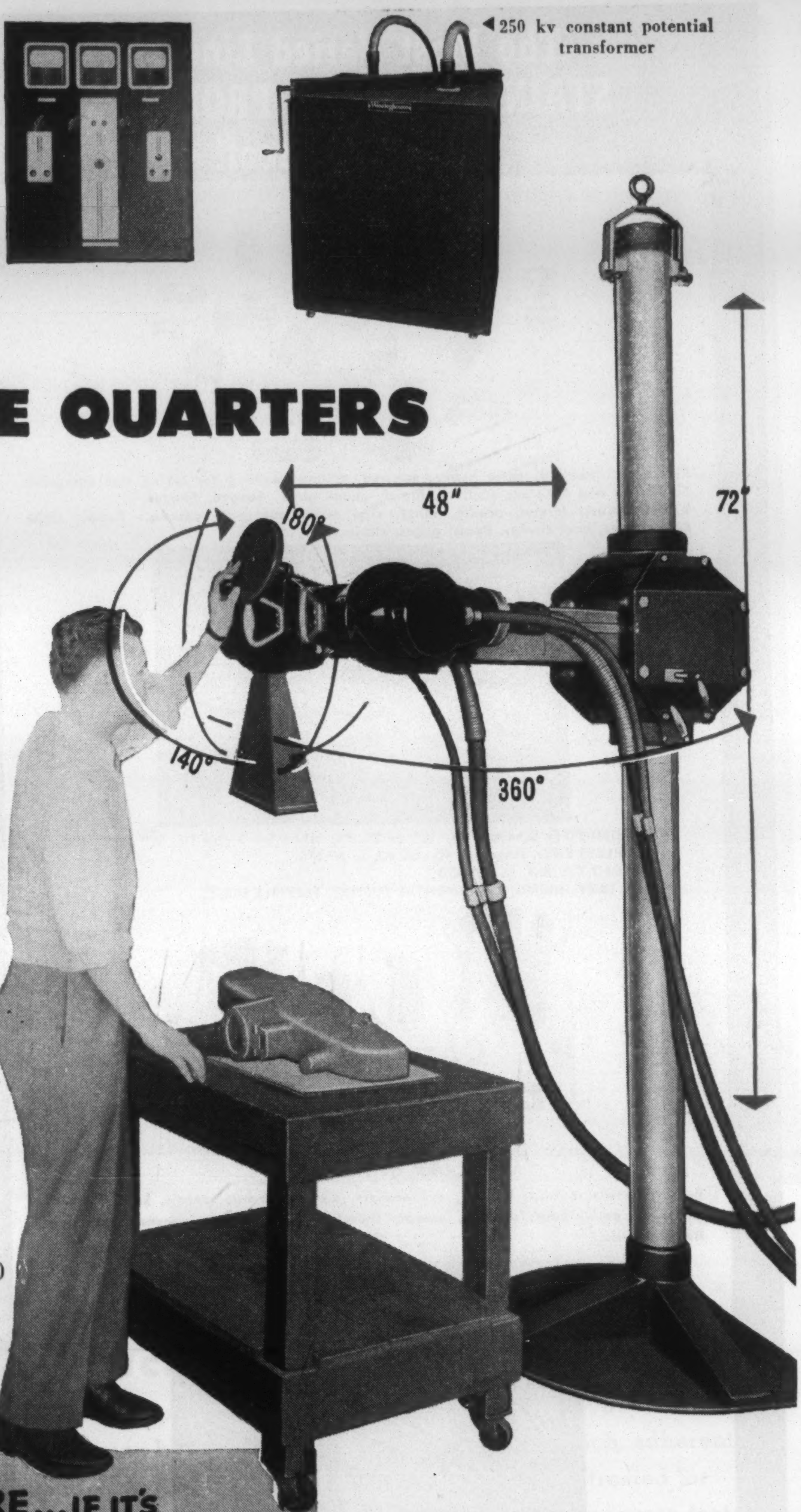

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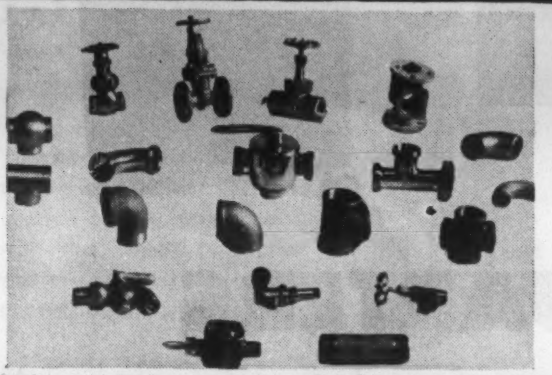

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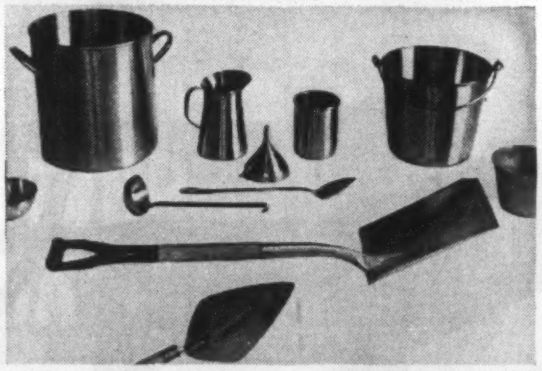

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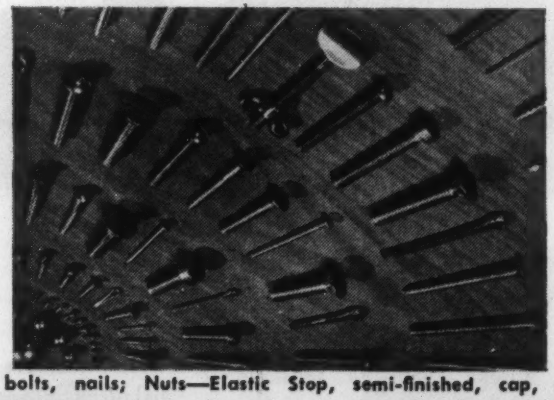

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Carpenter 20

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SCHNITZER ALLOY PRODUCTS COMPANY
1521 Pine Street
Elizabeth, New Jersey

Hubka, Norris F. Dow and Paul Seide. Oct. 1951 (NACA TN 2514). An analysis is made and charts are presented for the determination of regions of efficient application of flat balsa-core sandwich and stiffened-panel construction for a large range of design requirements. Optimum sandwiches were found to have relatively low values of the ratio of core thickness to face thickness.

"A Survey of Creep in Metals." A. D. Schwope and L. R. Jackson, Battelle Memorial Institute. Nov. 1951 (NACA TN 2516). This report summarizes numerous theories relating to creep phenomena and the extent of current knowledge on the subject. Various possible mechanisms by which creep occurs both in single crystals and in polycrystals are described. An extensive bibliography of published works in this field is also included.

"Rotogenerative Detection of Corrosion Currents." Joseph B. McAndrew, William H. Colner and Howard T. Francis, Armour Research Foundation. Nov. 1951 (NACA TN 2523). A new technique for studying corrosion phenomena is described which permits the detection of the presence of currents produced by local cells on the surface of a corroding metal specimen. A cylindrical specimen is rotated at several hundred revolutions per minute in the corrosion medium. A small reference electrode is positioned as near the specimen as possible, thus scanning the surface of the metal. The signal produced is amplified and applied to an oscilloscope, together with a suitable synchronized sweep voltage. A standing pattern is produced on the oscilloscope which is a reproduction of the potential fields set up in the corrosion medium by the currents flowing between the elements of local cells.

"Corrosion of Metals. Metals Under Stress: I Aluminum." P. F. Thompson. July 1950 (Dept. of Supply ACA-49, available on loan only). Discusses the corrosion of aluminum under stress. Gives time-potential curves determined simultaneously of stressed and unstressed electrodes of commercially pure aluminum. Test pieces of various shapes were used. Determinations were made in various liquids, including distilled water, tap water, salt solutions and sea water; and so that full assessment of the oxidizing potentials could be

Ebonol-Z a gleaming black finish for Zinc

Beautiful,

jet-black, like polished Ebony

These zinc automobile door handles are typical of the products processed in Ebonol-Z. This simple, one-dip method imparts to zinc base diecastings and plated parts, a rich, adherent black coating with good weathering qualities. Parts need only to be cleaned and then treated for a few minutes in a warm solution of Ebonol-Z. Chemical cost is one-half cent per square foot of the area coated . . . cheaper than plating or painting. Now used for finishing war materiel, and typewriters, business machines, toys, cameras, radios, name plates, buttons, and buckles.

Samples processed in our laboratory.

Detailed procedures supplied without obligation.

○ Ebonol-S for steel
○ Ebonol-C for copper and brass
○ Ebonol-Z for zinc

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Sixty Products and Processes for Metal Finishing

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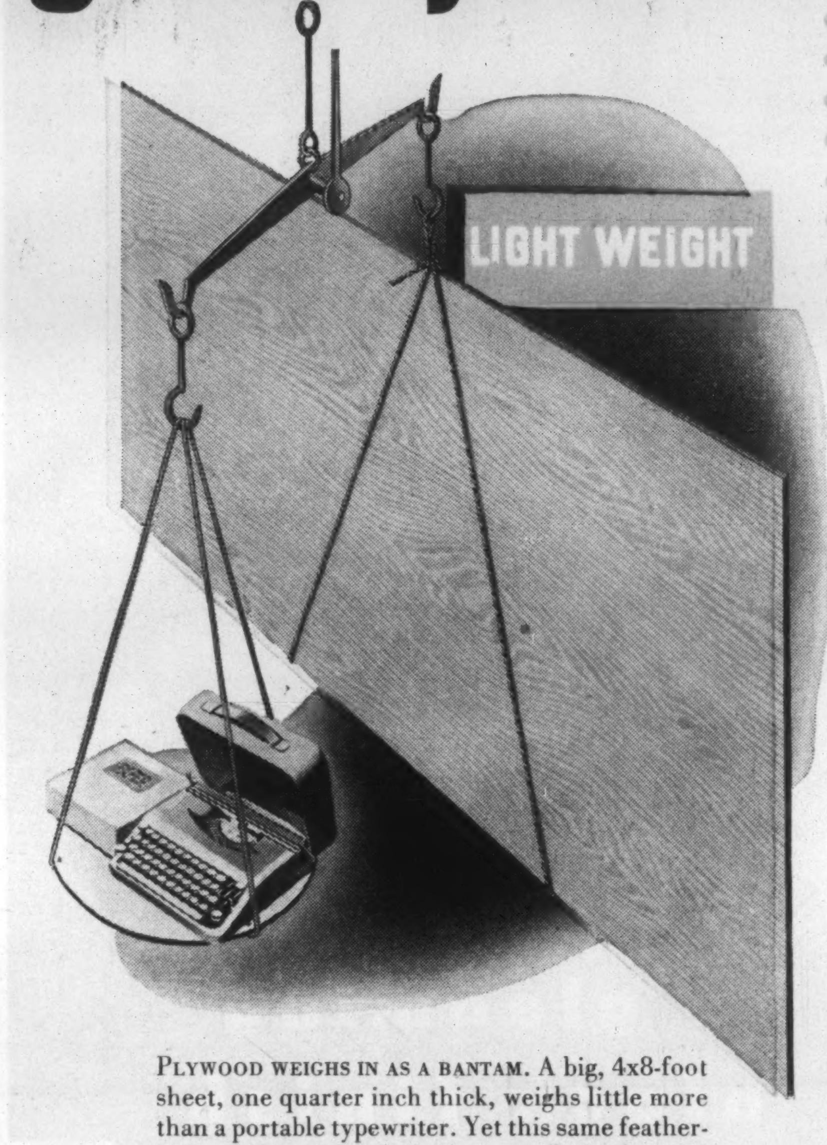
Only plywood gives you all 6

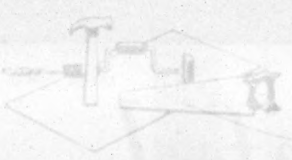


1 Light Weight

2 Cross Laminated Strength

3 Large Panel Size

4 Attractive Appearance


5 Workability

6 Tested Quality

PLYWOOD WEIGHS IN AS A BANTAM. A big, 4x8-foot sheet, one quarter inch thick, weighs little more than a portable typewriter. Yet this same featherlight real wood panel shrugs off shocks and bruising impacts that would split ordinary lumber, tear or dent metals, shatter composition materials.

This light-weight strength is but one of plywood's unique combination of advantages which make it a standout choice for hundreds of building, maintenance, processing, packaging and product-improvement jobs.

If you have a job where these six important advantages pay off, plan it with plywood. For free fact-filled plywood design folder write Douglas Fir Plywood Association, Dept. 461, Tacoma, Wash.

Douglas fir plywood is real wood, made by "unwinding" giant logs

into thin wood sheets which are inseparably cross-laminated...

to form large, light panels having beauty and great strength

Douglas Fir Plywood

AMERICA'S BUSIEST BUILDING AND INDUSTRIAL MATERIAL

News Digest

made, these solutions were examined under full aeration and under complete deaeration. The conclusions following on the work of this report indicate that stresses are but contributory factors in the so-called process of "stress corrosion."

Resistance Welder Manufacturers Announce Prize Paper Contest

Announcement has been made by the Resistance Welder Manufacturers Association of their annual Prize Paper Contest, which offers a total of $2250 in prizes for outstanding papers dealing with resistance welding subjects.

The contest provides an opportunity to those in Industry or engaged in research laboratory work to compete for a first prize of $750, a second prize of $500 and a third prize of $250. Papers emanating from a university source (the author of which is either an instructor, graduate student or research fellow) are eligible to a $300 prize and a second prize in this classification of $200. Undergraduate students may submit papers for a $250 award.

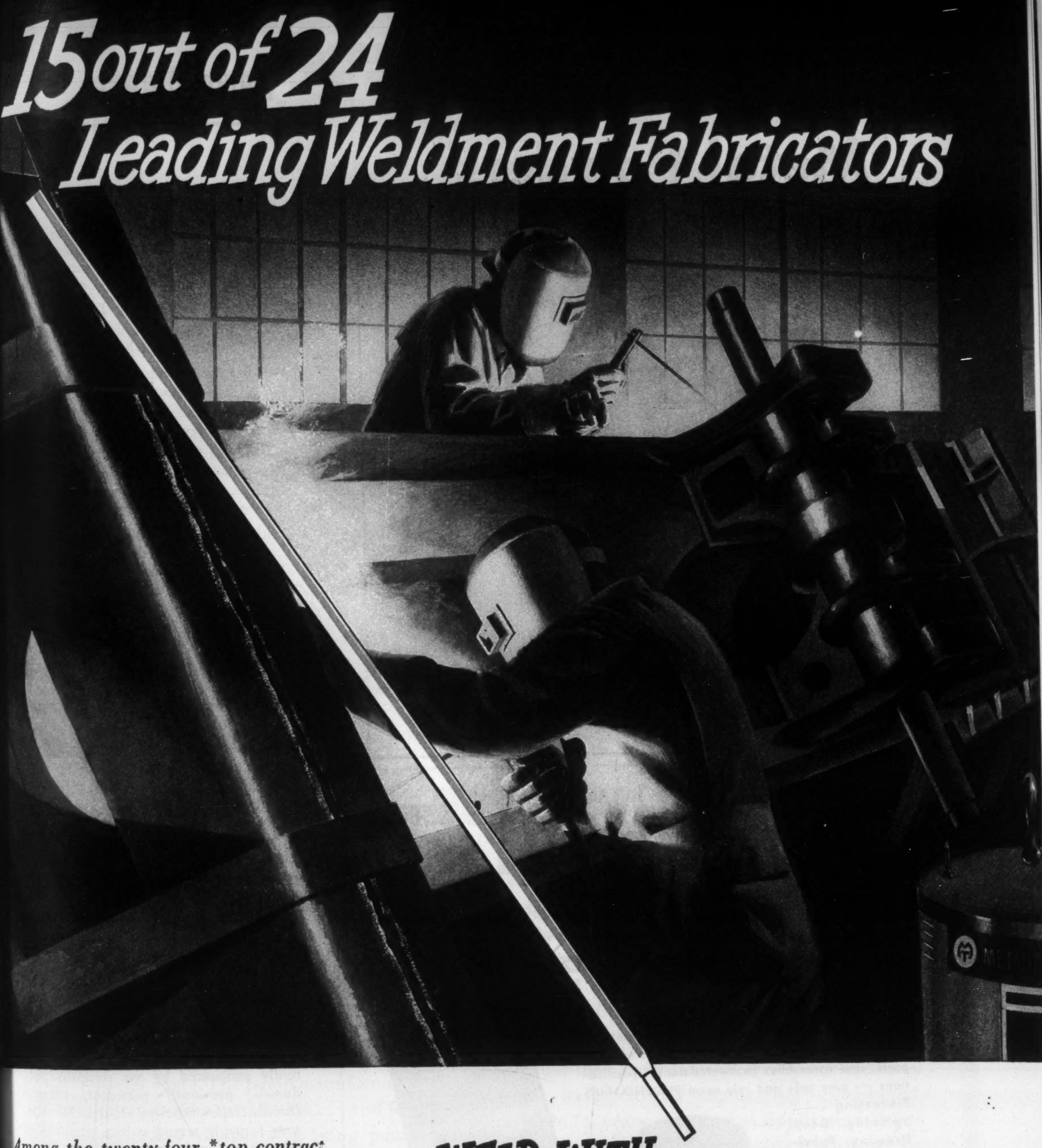
The contest is open to any one without restriction in the above categories located in the United States, its possessions and Canada. The contest judges will be appointed by the American Welding Society, and awards will be made at the 1952 fall meeting of the Society.

News of Engineers

The Hanson-Van Winkle-Munning Co. has announced the appointment of *Bernard C. Case* as manager of electrochemical development.

Ralph R. Kelley has recently joined the Brooks and Perkins staff as general superintendent of the new magnesium rolling mill, to be called Livonia Mill Div.

Luis E. Eckelmann, manager of the Metal Finishing Div., has been elected vice president of Pyrene Manufacturing Co. Mr. Eckelmann will be in general charge of



*Among the twenty-four *top contract welding firms, fifteen regularly weld with Murex Electrodes.*

More of the leaders in important industries prefer Murex Electrodes in their welding operations because they can be sure of sound welding—high deposition rates for economy and speed of production.

*Those having AAAA directory ratings.

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Copper Powder
(ELECTROLYTIC GRADE)

Atomized Copper Base
Alloy Powders

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Processing
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If your products require the close tolerances demanded by leading producers of aircraft engines, parts, and assemblies to meet defense specifications — play safe and rely upon PHOENIXSPUN Processing . . . Spinning, Deep Drawing, Fabricating.

Prompt Response To Your Inquiries.

Stainless Steel and Aluminum Parts for Gas Turbine Aircraft Engines.

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News Digest

development work as well as of metal finishing.

Appointment of *L. A. Roe* as director of the mining and metallurgical section of the Bjorksten Research Laboratories, Inc. was recently announced by the company.

The Commonwealth Engineering Co. has appointed *Alfred Lippman, Jr.* as general manager of its laboratories.

The appointment of *A. Bruce Mainwaring* as plant superintendent has been announced by Uniform Tubes.

Maurice Harp has joined the engineering staff of Lenkurt Electric Co. His function will be that of applications engineer for the development of f-m and single-side-band space-carrier equipment.

Rheem Manufacturing Co. has announced the appointment of three plant managers: *William S. Rheem* as manager of the South Gate, Calif. plant; *Lloyd Simonson* as manager of the Sparrows Point, Md. plant; and *Harry H. Filler* as manager of the Bayonne and Linden, N. J. plants.

At a recent directors' meeting, *Alan R. Burman* was appointed to the board of directors and the position of vice president of the Cro-Plate Co.

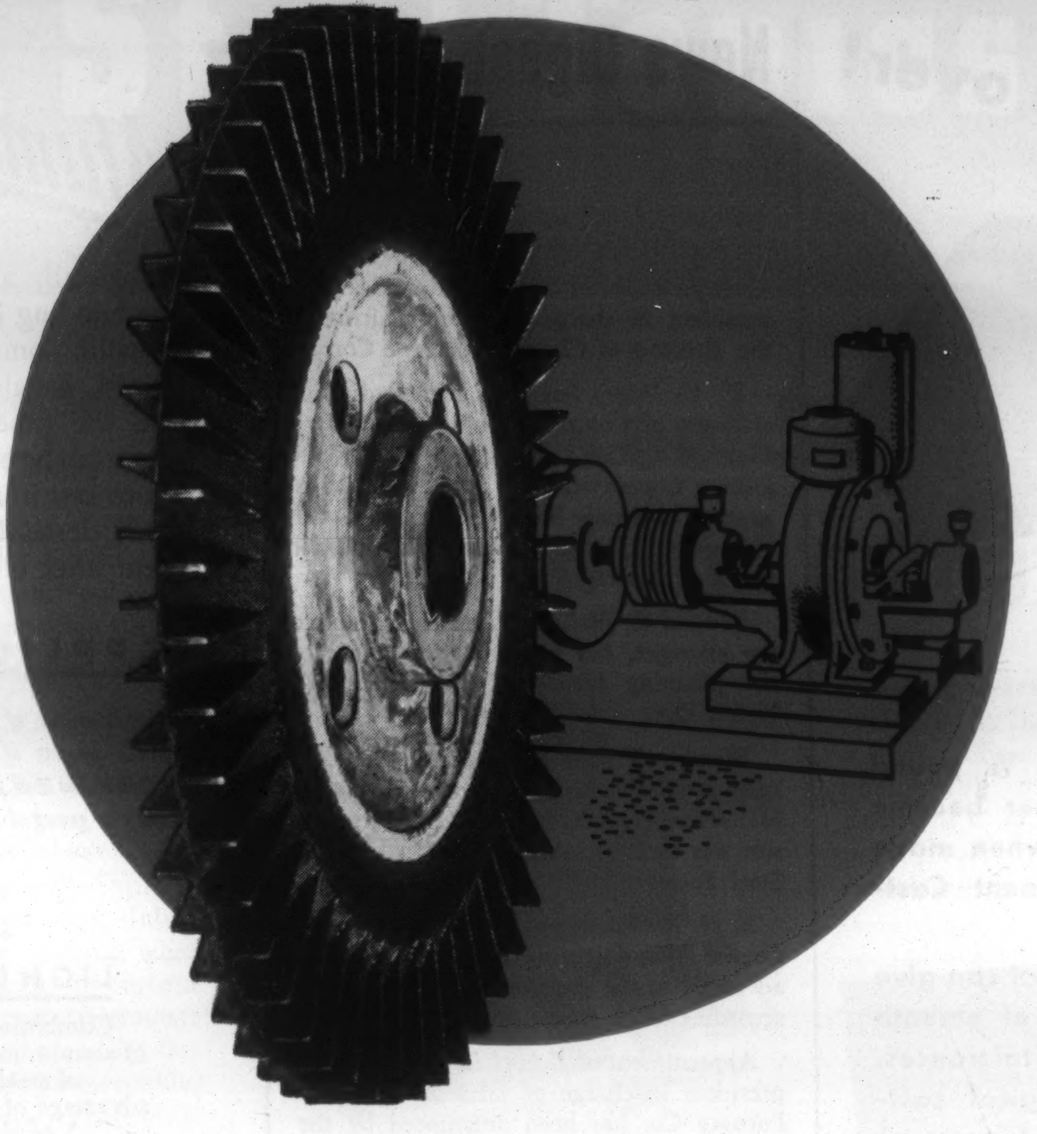
. *Edwin D. Howell* has recently been named assistant manager of the Rome Manufacturing Co. Div. of Revere Copper and Brass, Inc. and *Chester M. McCreery* has been named manager of the division. Another appointment announced by the company was that of *Harold J. Schindler* as works manager of the Clinton Manufacturing Div.

George Stern and *Richard P. Seelig* have recently been named vice presidents of the American Electro Metal Corp., according to a recent company release.

Election of *James J. Russell* as chairman of the board and chief executive officer, and *James M. Kennedy* as president of Revere Copper and Brass, Inc. was recently announced by the company. Mr. Russell, previously president, succeeds *Donald Dallas,* who has retired. Mr. Kennedy formerly served as vice president of the company in charge of the Rome Manufacturing Co. Div.

Two major promotions in the management of the locks and hardware manufacturing operations of The Yale & Towne Manufacturing Co. have been announced. *Leo J. Pantas,* works manager of the Salem, Va. Div. has been appointed general manager of the Stamford Div.; *Marvin C. Bonine* has been named to succeed Mr. Pantas.

New appointments have been announced by Cutler-Hammer, Inc. *Philip Ryan* has been named executive vice president, in addition to his duties as vice president in charge of manufacturing; *R. A. Millermaster* has been appointed manager of the Development Dept. and *C. W. Kuhn* has



Found:

The 2% that cured a Pickled Pump

How years of N-B-M Metallurgical experience paid off by solving a severe problem of corrosion

When a vinegar producer suddenly starts having frequent pump failures due to extreme impeller corrosion, it's pretty evident that something unusual is going on . . . particularly when the same pump had been used successfully for years. The pump manufacturer sent an engineer to the installation . . . and found that *concentrated* vinegar was being pumped, instead of *diluted* vinegar as before. Impellers in some cases were lasting only 1 week.

The pump manufacturer came to us with the facts—and our Metallurgical Department was immediately put to work on the problem.

Result? In a matter of days, impellers of a new alloy were on their way with a slight but important alloy change . . . the addition of 2% nickel. These impellers now last 18 months to 2 years—longer than they ever had before!

We're proud of examples like this . . . because they show how effectively our facilities for Research and Engineering — combined with 75 years of practical application experience — make money-saving solutions to problems on . . .

Non-Ferrous Bearings and Castings—
As-Cast or Machined

Bronze Bars—
As-Cast or Machined;
Cored, Solid, Hexagon

Babbitt Metals—
For every type of
bearing service

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Brake Shoe
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it's a push over!

Problems like this ½ pound Stainless Steel pusher become simple push overs when made as Precision Investment Castings.

This is the process that can give you a combination of smooth surface finish, close tolerances, and sound metallurgical castings in any alloy, ferrous or non-ferrous.

Let us prove that your small *problem parts* can be made simple push over jobs with lower production costs.

The process is adaptable to either small or large quantity runs.

Send prints for quotation without obligation.

Please use the coupon.

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107 N. Franklin Street, Syracuse 4, N. Y.

Small precision castings of ferrous and non-ferrous alloys.

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News Digest

been named director of development engineering for the company.

A. J. Wilhelm has been elected as vice president in charge of manufacturing by the directors of Clearing Machine Corp.

T. Y. Henry has been named division manager of Copperweld's new subsidiary, Flexo Wire Co., Oswego, N. Y. Prior to joining Copperweld, Mr. Henry was manager of Materials Section, Division Standardizing, of the RCA Victor Div., Radio Corp. of America.

Edward R. McLean, former assistant to the manager, has been made manager of the planning section of du Pont Co.'s Nylon Div.

Warden Wilson has become president and general sales manager of Donegal Manufacturing Co., Marietta, Pa. Mr. Wilson was formerly associated with Lebanon Steel Foundry.

E. H. Rocks, formerly chief engineer of Greene Manufacturing Co., has just been advanced to the position of vice president, according to a recent company release.

Appointment of *Daniel L. Wertz* as vice president in charge of sales of The Dow Furnace Co. has been announced by the company's president.

United States Bronze Powder Works, Inc. has announced the appointment of *Erich Fetz* as director of research.

Donald F. Kane, recently with Factory Mutual Engineering Division Associates, has joined the engineering staff of Hunt-Spiller Manufacturing Corp.

The election of *Carl E. Scholz* as vice president and chief engineer of the American Cable & Radio Corp. has been announced by the company.

Promotion of Dr. *J. O. Hendricks* to the newly-created post of associate director of the Minnesota Mining & Manufacturing Co.'s central research laboratories was announced recently by the central research director. Drs. *Matthew W. Miller* and *H. M. Scholberg* were also named as assistant directors.

Henry E. Jensen has been named chief engineer for C & D Batteries, Inc.

Promotion of *Henry A. Denny* to the position of production manager, Engineering and Construction Div. of Koppers Co., Inc. was recently made known by the company. Mr. Denny, formerly assistant production manager, succeeds *Frank Chambers.*

Karl H. Meyer, who has been manager of the Ashtabula plant of The Reliance Electric & Engineering Co., will return to Cleveland as manager of the company's Ivanhoe Div. Mr. Meyer will be succeeded by *Walter H. Haber.*

Recent recipients of engineering honors which were awarded at the annual meeting of the American Society of Mechanical

Alumibonding

is basically a casting process—the bonding layer being an intermetallic compound of the two joined metals. Pure aluminum and the generally used casting alloys can be bonded by this process to cast iron, carbon and alloy steels, or stainless steel. Heat treatment after bonding is possible.

APPLICATIONS

Applications of the ALUMIBONDING process of molecularly bonding aluminum and its alloys to steel or iron may be grouped into four classes:

LIGHTWEIGHT

Combining the lightness of aluminum and the strength of steel and taking advantage of the machinability of aluminum.

HEAT DISSIPATION

BEARING PROPERTIES

CORROSION RESISTANCE

WRITE TODAY FOR ALUMIBOND* BOOKLET

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ENGINEERING WORKS
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Tool Steel Topics

BETHLEHEM STEEL

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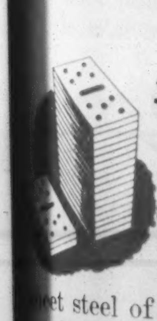
How the Right Steel Solved These 3 Tool Problems

Our metallurgical servicemen and distributors are constantly on the job to help users get the most out of their tool steel. Here are the highlights of some recent tool problems solved by selecting a more suitable steel.

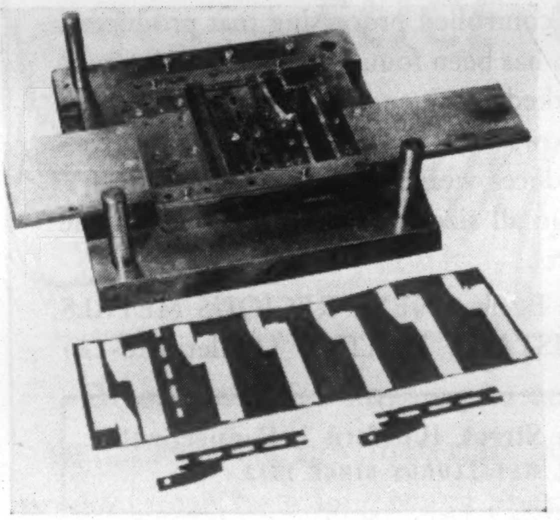
A MAKER OF AUTOMOBILE BUMPERS had been getting poor service from shear blades for trimming hot-rolled spring steel. High-speed steel didn't wear long enough and the cutting edge peened. High-carbon, high-chromium tool steel (our Lehigh H) was tried next. It had plenty of wear-resistance, but the cutting edges developed chipping trouble. **SOLUTION:** Our man suggested Lehigh L (a high-chromium grade with lower carbon). This worked fine — because it had sufficient wear-resistance combined with more toughness.

AN AIRCRAFT FIRM WAS BOTHERED by the cracking of some special wrenches for assembling aircraft parts. The wrenches had very sharp corners, and both thin and thick sections. The application called for plenty of toughness and a fair amount of wear-resistance. The firm had been making these wrenches from a low-carbon type of silico-manganese tool steel, and they were cracking in the water-quenching operation. **SOLUTION:** We recommended Omega. With its less drastic oil-quench and inherent toughness, it has licked the cracking trouble.



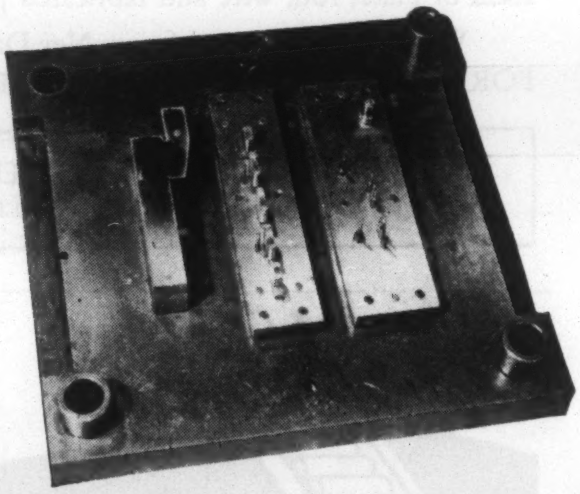
A SHEET-METAL FABRICATOR COMPLAINED to a Bethlehem salesman about the premature breakage of small-diameter punches. Rather long and slender, the punches were used on sheet steel of greater thickness than the punch diameter. (It's usually best for the punch diameter to be greater than the thickness of material being punched.) The punches were subjected to excessive side thrust; constant breakage was running up production costs. **SOLUTION:** They tried 67 Chisel, our chrome-tungsten grade of shock-resisting tool steel. Result: punches produced about eight times as many blanks as previously.

Die turns out 500,000 pieces ... and still going strong



This progressive die, made of BTR, performs a perforating, notching, and blanking operation in the production of condenser brackets. This popular grade of oil-hardening steel was selected by the user because it's easy to heat-treat . . . it has good resistance to distortion in heat-treatment and it's easy to machine.

The long-wearing qualities of BTR are evidenced by the production of more than a half-million pieces at the time the photograph was made. Hardened to Rockwell C-59, it produces about 30,000 parts from 3/32-in. steel strip before redressing is needed.



Our Tool Steel Engineer Says:

Rapid wear is caused usually by improper heat-treatment

When tools fail by wearing too rapidly, the trouble can usually be traced to inadequate heat-treatment resulting in decarburized surfaces, improper quenching that produces low hardness, and other faulty procedures.

However, poor wear-resistance may also result from the use of the wrong type of tool steel. If a blanking die is made of a 0.60 pct carbon steel of the shock-resisting type, it can't be expected to wear as long as a 1.50 pct carbon steel having a high chromium content.

NEW USE FOR HIGH-SPEED STEEL

An enterprising apprentice in a tool shop stumbled on a small cache of round steel bars the other day. They were just the right size he needed for a small storage rack the foreman had asked him to build. He made a nice job of it. "This ought to make a hit with the foreman," he thought as the last bar was fitted into place.

When the foreman took one look at the rack, he recoiled in horror. "Oh, no!" he groaned. To the puzzled apprentice the foreman growled, "Young fella, that rack you've got there is worth about ten times the cost of the carbon steel bars it's going to hold. Looks like you've used up every piece of my high-speed steel."

Bethlehem ULTRASONIC TESTED **Tool Steel**

NEY #90 ALLOY

"JUST RIGHT" HARDNESS . . . SURFACE FINISHED FOR SLIP RINGS AND COMMUTATOR BARS

NEY #90 Alloy, overcomes many of the disadvantages of coin silver when used in slip ring and commutator bar applications. Actually a modification of coin silver, NEY #90 is subjected to a carefully controlled processing that produces a uniform hardness of 120-130 Brinell which has been found best for slip ring type applications. Since performance is also markedly influenced by surface condition, especially when brush pressure must be low, NEY #90 Alloy rings are given a specially developed finish that greatly reduces wear and electrical noise. NEY #90 Alloy is available in seamless tubing in all sizes up to 4" O. D., also in the form of plate, rod, wire and fabricated parts.

Write for your copy of new Ney Data Book, "NEY PRECIOUS METALS FOR NON-CORROSIVE WEAR-RESISTANT PARTS." (Bulletin R-12)

THE J. M. NEY COMPANY, 105 Elm Street, Hartford 1, Connecticut
SPECIALISTS IN PRECIOUS METAL METALLURGY SINCE 1812.

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SCALE-FREE FORGING HEAT

SAVES STEEL

Heating scale wastes steel—up to 3/64" of the billet's outer surface.

Ajax-Northrup induction heat works so fast there's no time for scale to form. Saves up to 20% of billet stock.

No worries about fuel shortages, either. Electrical power is always available.

Whether it's for forging, hardening or brazing, Ajax-Northrup induction heat can do the job faster, better and at lower overall cost.

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News Digest

Engineers held in Atlantic City were: *William L. Batt,* minister in charge of the Economic Cooperation Administration Mission to the United Kingdom, who received the Hoover Medal; *Ervin G. Bailey,* vice president of the Babcock and Wilcox Co., who was awarded the John Fritz Medal; and *Thomas Roy Jones,* president of Daystrom, Inc., winner of the Henry Laurence Gantt Medal.

The Vonnegut Moulder Corp. has appointed *Oliver S. DeHaven* to re-assume the duties of chief engineer after an absence of four years. The company has also announced that *Eric Lindenborg* has joined its Engineering Div. Mr. Lindenborg will be in charge of demonstrations and experiments related to Vonnegut grinding and polishing equipment.

The Lithium Co. has announced the promotion of *Frank A. Rusciano* from chief engineer to vice president and works manager of the company.

Carnegie Institute of Technology's Merit Award for worthy achievement has been presented to *Thomas D. Jolly,* vice president in charge of engineering and purchasing for the Aluminum Co. of America.

For the fourth time in six years, a Westinghouse research engineer has won the annual $750 award made by the American Welding Society for the best paper on resistance welding. This time it was *W. Leslie Roberts* of the Westinghouse Research Laboratories, for his paper "Resistance Variations During Spot Welding."

Theodor D. Meyer, formerly superintendent of Australian Abrasive Pty., Ltd., a Norton associate company in Auburn, New South Wales, was appointed production engineer of the Abrasive and Wheel Div., Norton Behr-Manning Overseas, Inc. Other news from Norton includes the appointment of *Gilbert H. Gidley* as abrasive engineer in Chicago, *Lorenzo S. Washburn* as quality manager of Norton Co.'s Abrasive Div., and *Clarence W. Halleen* as superintendent of plants 1, 2 and 3.

Thurston V. Ely has recently been appointed sales manager of Randolph Products Co. Mr. Ely will supervise sales of special industrial finishes.

Rogers Corp. has announced the appointment of *Benjamin B. Levy* as sales manager of the company.

Recent appointments and changes within its organization has been announced by General Electric Co. *L. Vernon Larsen,* of the company's Chemical Div., has been appointed engineering section head of G-E Textolite industrial and decorative laminates; *William L. Rodich* has been promoted to assistant general manager of the Laminated and Insulating Products Dept. of the Chemical Div.; *Earl F. Arnett,* of the Chemical Div., has been named manufacturing engineer for the Coshocton, Ohio

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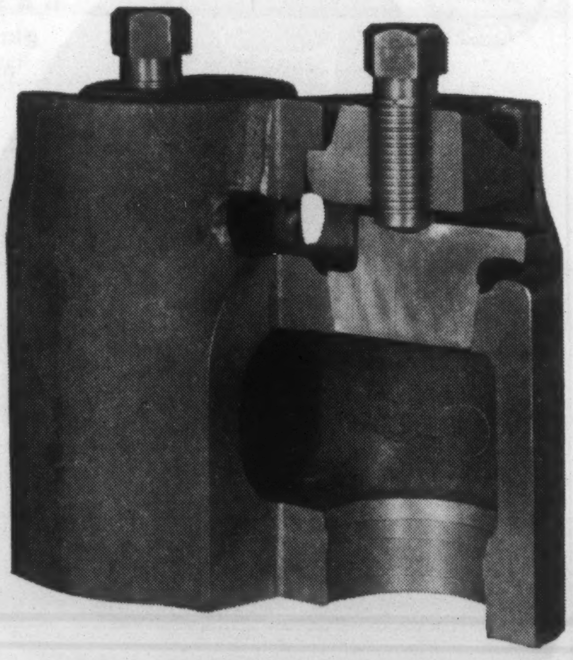
Most foundries have equal access to equipment and raw materials but their products can be a long ways apart in quality. The difference can usually be summed up in one word . . . experience.

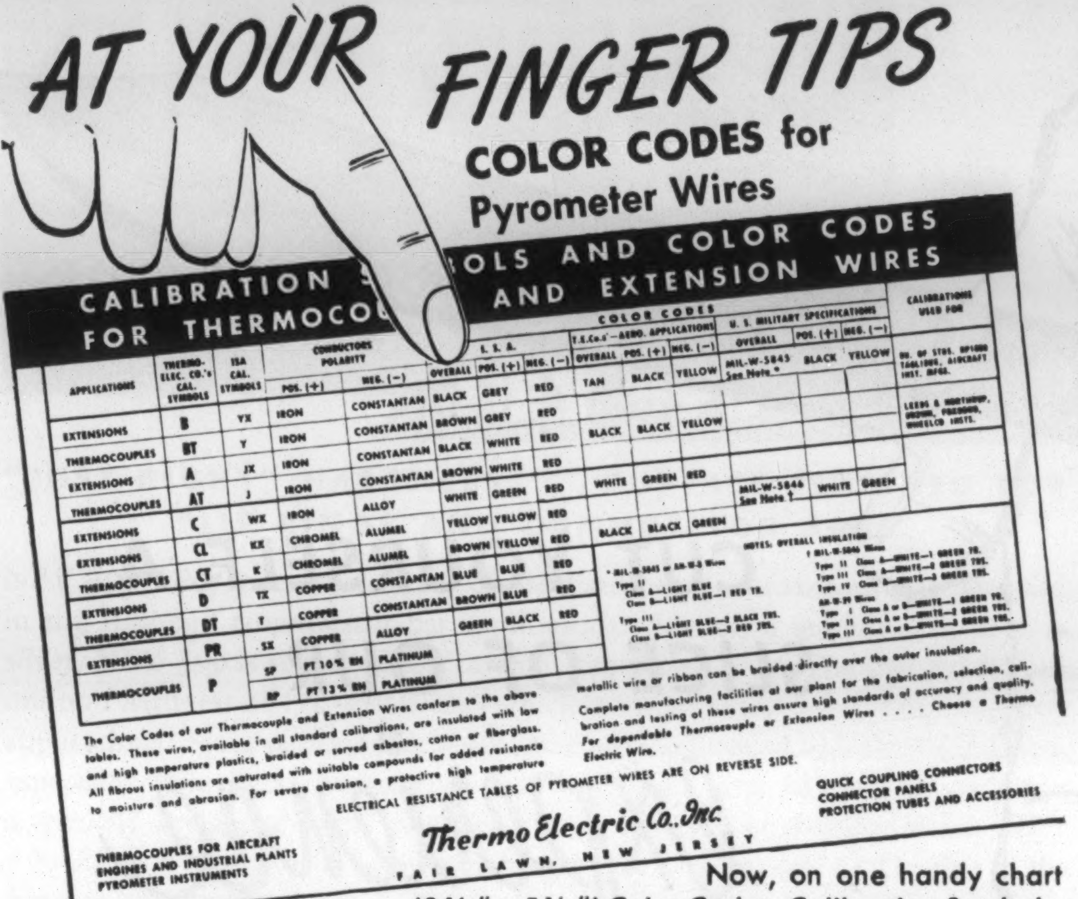
For over 42 years Sivyer has specialized in high alloy and specification steel castings. This accumulated "Know-how" can serve you in solving your special steel casting problems . . . in providing castings designed to lower your machining time, eliminate flaws and provide longer more dependable service life.



SIVYER

SPECIALISTS IN HIGH ALLOY AND SPECIFICATION STEEL CASTINGS

SIVYER STEEL CASTING COMPANY • MILWAUKEE ◇ CHICAGO ◇



AT YOUR FINGER TIPS

COLOR CODES for Pyrometer Wires

CALIBRATION SYMBOLS AND COLOR CODES FOR THERMOCOUPLE AND EXTENSION WIRES

APPLICATIONS	THERMO-ELEC. CO.'s CAL. SYMBOLS	ISA CAL. SYMBOLS	CONDUCTORS POLARITY		COLOR CODES									CALIBRATIONS USED FOR
					I. S. A.			T.E.Co.'s—AERO. APPLICATIONS			U. S. MILITARY SPECIFICATIONS			
			POS. (+)	NEG. (−)	OVERALL	POS. (+)	NEG. (−)	OVERALL	POS. (+)	NEG. (−)	OVERALL	POS. (+)	NEG. (−)	
EXTENSIONS	B	YX	IRON	CONSTANTAN	BLACK	GREY	RED	TAN	BLACK	YELLOW	MIL-W-5845 See Note *	BLACK	YELLOW	[illegible] OF STDS. [illegible] TAGLIBUE, AIRCRAFT INST. MFGS.
THERMOCOUPLES	BT	Y	IRON	CONSTANTAN	BROWN	GREY	RED							
EXTENSIONS	A	JX	IRON	CONSTANTAN	BLACK	WHITE	RED	BLACK	BLACK	YELLOW				LEEDS & NORTHRUP, BROWN, FOXBORO, WHEELCO INSTS.
THERMOCOUPLES	AT	J	IRON	CONSTANTAN	BROWN	WHITE	RED							
EXTENSIONS	C	WX	IRON	ALLOY	WHITE	GREEN	RED	WHITE	GREEN	RED	MIL-W-5846 See Note †	WHITE	GREEN	
EXTENSIONS	CL	KX	CHROMEL	ALUMEL	YELLOW	YELLOW	RED							
THERMOCOUPLES	CT	K	CHROMEL	ALUMEL	BROWN	YELLOW	RED	BLACK	BLACK	GREEN				
EXTENSIONS	D	TX	COPPER	CONSTANTAN	BLUE	BLUE	RED							
THERMOCOUPLES	DT	T	COPPER	CONSTANTAN	BROWN	BLUE	RED							
EXTENSIONS	PR	SX	COPPER	ALLOY	GREEN	BLACK	RED							
THERMOCOUPLES	P	SP	PT 10% RH	PLATINUM										
		RP	PT 13% RH	PLATINUM										

NOTES: OVERALL INSULATION

* MIL-W-5845 or AN-W-5 Wires
Type II
Class A—LIGHT BLUE
Class B—LIGHT BLUE—1 RED TR.
Type III
Class A—LIGHT BLUE—2 BLACK TRS.
Class B—LIGHT BLUE—2 RED TRS.

† MIL-W-5846 Wires
Type II Class A—WHITE—1 GREEN TR.
Type III Class A—WHITE—2 GREEN TRS.
Type IV Class A—WHITE—3 GREEN TRS.
AN-W-29 Wires
Type I Class A or B—WHITE—1 GREEN TR.
Type II Class A or B—WHITE—2 GREEN TRS.
Type III Class A or B—WHITE—3 GREEN TRS.

The Color Codes of our Thermocouple and Extension Wires conform to the above tables. These wires, available in all standard calibrations, are insulated with low and high temperature plastics, braided or served asbestos, cotton or fiberglass. All fibrous insulations are saturated with suitable compounds for added resistance to moisture and abrasion. For severe abrasion, a protective high temperature metallic wire or ribbon can be braided directly over the outer insulation.

Complete manufacturing facilities at our plant for the fabrication, selection, calibration and testing of these wires assure high standards of accuracy and quality. For dependable Thermocouple or Extension Wires . . . . Choose a Thermo Electric Wire.

ELECTRICAL RESISTANCE TABLES OF PYROMETER WIRES ARE ON REVERSE SIDE.

THERMOCOUPLES FOR AIRCRAFT
ENGINES AND INDUSTRIAL PLANTS
PYROMETER INSTRUMENTS

Thermo Electric Co., Inc.
FAIR LAWN, NEW JERSEY

QUICK COUPLING CONNECTORS
CONNECTOR PANELS
PROTECTION TUBES AND ACCESSORIES

Now, on one handy chart (8½" x 5½") Color Codes, Calibration Symbols, Thermo Elements of Thermocouple and Extension Wires for ISA, U.S. Military and Aeronautical Specifications — Plus — Resistance Tables.

Write Today for your copy. No obligation, of course.

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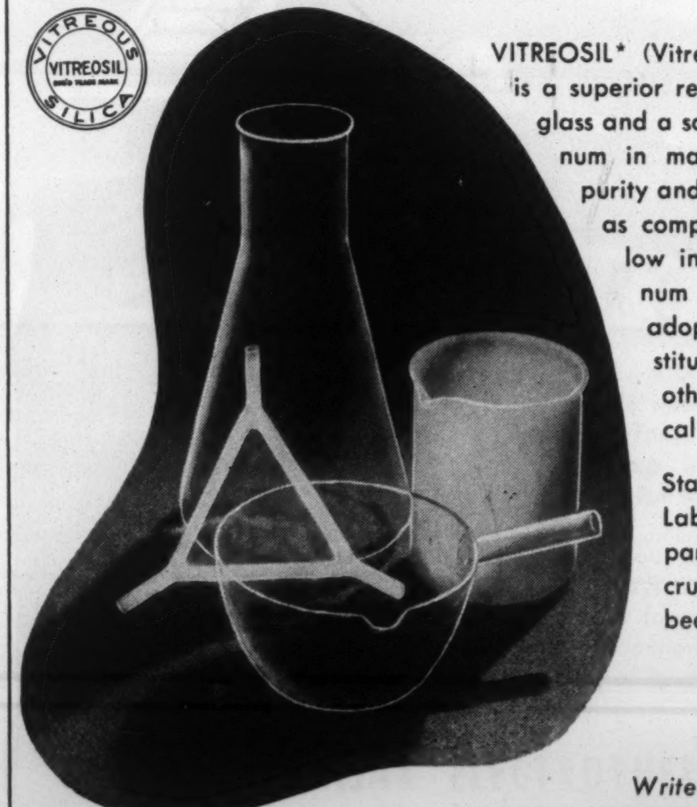

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News Digest

plant of the division's Laminated and Insulating Products Dept.

Harbison-Walker Refractories Co. has announced the appointment of *Harry H. Yeager* as general superintendent of plant operations.

Westinghouse Electric Corporation has announced the death of *Leon R. Ludwig*, director of engineering and research for the corporation's Atomic Power Div.

The Driver-Harris Co. has been advised of the death of *Sylvio C. Leoni* in Milan, Italy. Mr. Leoni was the managing director of two subsidiaries of the company.

The death of *Robert N. Blakeslee*, vice president and director of engineering of Ajax Electrothermic Corp., has been announced by the company.

News of Companies

Peter A. Frasse & Co., Inc. recently held opening ceremonies at their new 80,000 sq. ft. warehouse located on Marin Ave. in Lyndhurst, N. J. The new building, part of the firm's program for expansion and modernization, is to be devoted to the distribution of alloy, stainless and cold finished carbon steels and tubing in the metropolitan area and Connecticut.

Formation of *Russell Reinforced Plastics Corp.*, to manufacture low pressure laminates and flat board stock of Fiberglas-polyester construction, has been announced. With main offices in Hicksville and plants in Lindenhurst, L. I., N. Y., the company is already in large scale production.

Vanadium-Alloys Steel Co. has opened a new laboratory, which is twice as large as the previous laboratory.

Construction of a major addition to its home facilities in East Hartford has begun at *Pratt & Whitney Aircraft Div.* of *United Aircraft Corp.* The addition is part of the company's privately-financed major building program to expand its defense production. Other projects now under construction include a new home for the Hamilton Standard Div. at Bradley Field, Windsor Locks, and a Pratt & Whitney Aircraft branch plant at North Haven.

Automatic Steel Products, Inc. has announced the acquisition of *Metroloy Corp.*, producers of cold formed steel articles.

United Lacquer Manufacturing Corp. has embarked on a new expansion program to triple its research facilities.

Plans to construct a $600,000 resorcin

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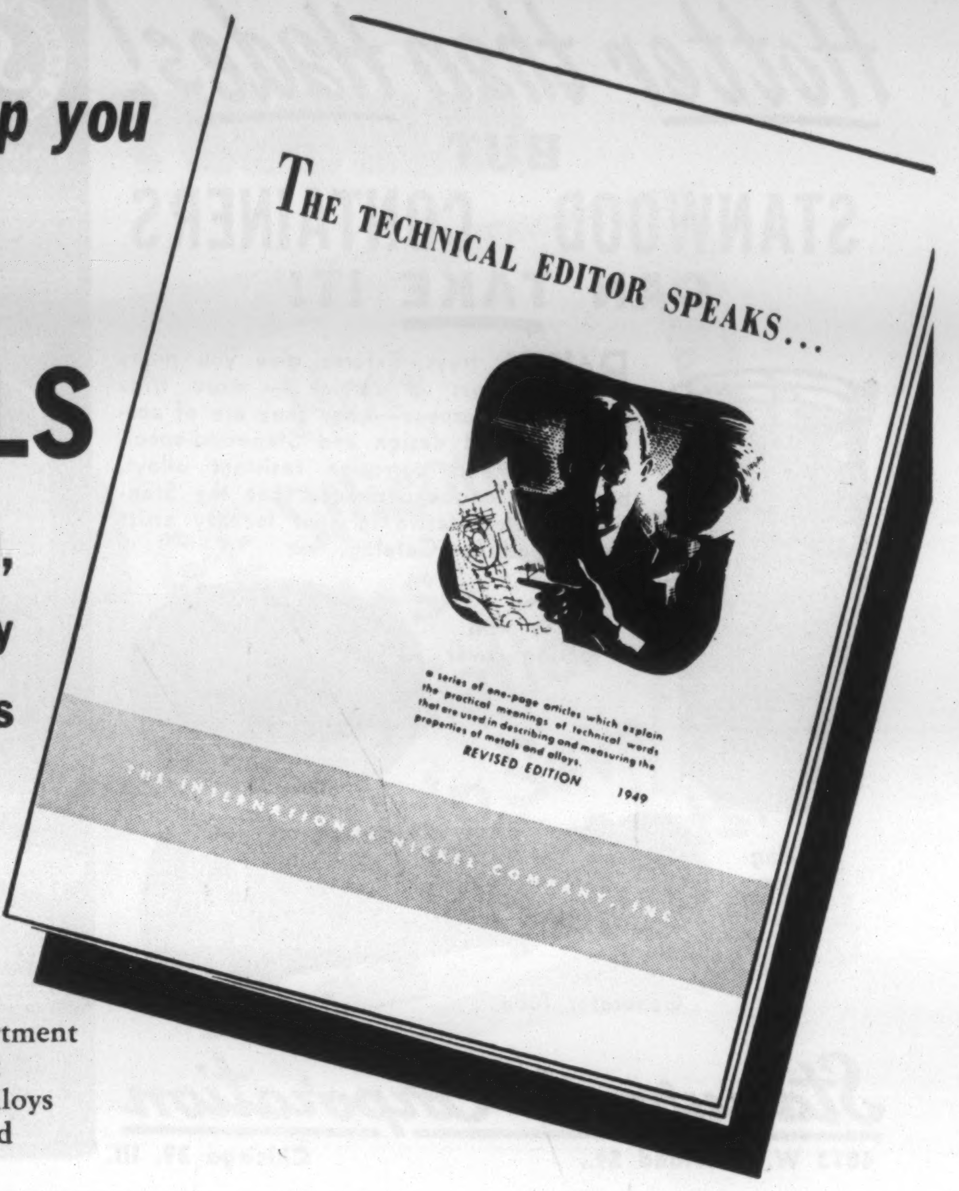

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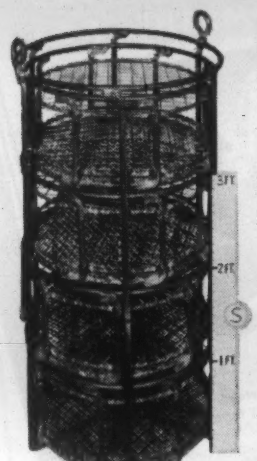
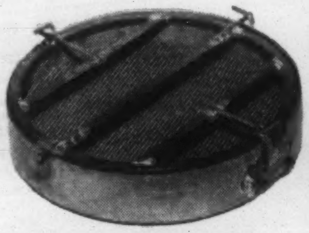
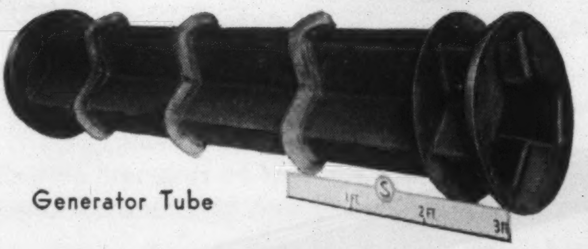


Stacking Fixture



Tray with locking cover



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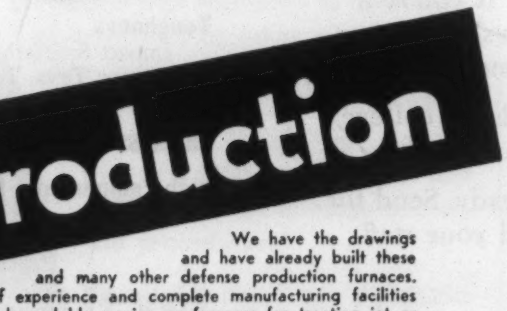

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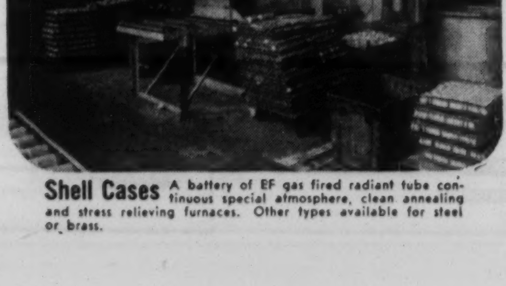


Shell Cases A battery of EF gas fired radiant tube continuous special atmosphere, clean annealing and stress relieving furnaces. Other types available for steel or brass.

News Digest

manufacturing plant in Los Angeles County were announced by the president of *Borden Co.'s Chemical Div.* Authorization to build the plant has been granted by NPA. When completed, it is expected that the new plant will produce at least 1,000,000 lb of technical grade resorcin annually.

Pittsburgh Plate Glass Co. will enter the fiber glass production field in the near future, according to a recent announcement from the company's executive vice president. Formation of a separate development and production unit, to be known as the *Fiber Glass Div.*, is now in progress. Two types of fiber glass, strand fiber and superfine fiber, will be manufactured under licensing agreement with *Owens-Corning Fiberglas Corp.*

Auburn Button Works, Inc. has just completed a new experimental laboratory for its recently expanded Extrusion Dept.

Rezolin, Inc. has announced the construction of a new $225,000 plant. The new building will occupy a full acre and is expected to be completed by Jan. 1.

Boston Woven Hose and Rubber Co. has broken ground on a new rubber reclamation plant.

Laminated Plastics, Inc. has changed its corporate name to *The Glastic Corp.*, according to a recent company release.

Harcraft Brass, a division of *Harvey Machine Co., Inc.*, has announced the completion of a new 2½-acre factory adjacent to its present plant. The new plant houses the expanded facilities for the production of the popular line of chromium-brass valves and fixtures.

United States Plywood of Canada Ltd. has announced the company name has been officially changed to *Weldwood Plywood Ltd.*

The Tocco Div., Ohio Crankshaft Co., has announced plans for its second "Economy in Production" contest. Contestants for the $3000 prize money must submit descriptive articles dealing with increasing production and/or decreasing cost with Tocco, and must describe actual installations of Tocco induction heating equipment.

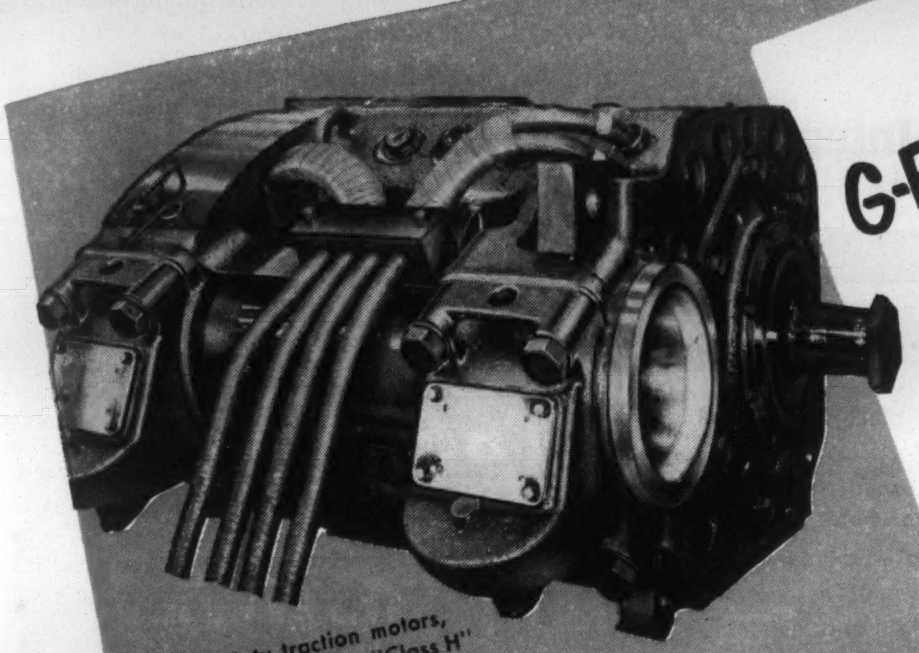
More than 15,000 persons toured the *Chase Metal Works Plant* during *Chase Brass & Copper Co.'s* recent Open House in Waterbury, Conn., sponsored by the company as parts of its 75th Anniversary celebration.

Construction of a new *Benchmaster Manufacturing Co.* plant has been announced by the company's president. Located on Rosecrans Blvd., the first unit will provide 20,000 sq ft of floor space on what will eventually be a 5-acre development.

Hooker Electrochemical Co. plans to build a new $10,000,000 plant for the

SILICONE PROGRESS

How G-E Silicones in Class H Insulation Help Save Rewind Costs



Heavy-duty traction motors, wound with the new "Class H" insulation made with G-E silicones, withstand high heat and mechanical stress.

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Longer life of electrical equipment at high temperatures—resulting in important savings in rewind costs and less down time—is made possible with a new class of General Electric silicone insulation. This "Class H" insulating material provides an unusually high overload capacity. It withstands temperatures up to 480 F for limited periods; has temperature resistance 90-135 degrees Fahrenheit *above* conventional insulating materials.

G-E silicone insulation offers engineers new opportunities to design motors for heavy-duty jobs. Traction motors, often subject to high operating temperatures and mechanical abuse, are being built with armature and field coils wound with glass-backed mica insulation bonded with G-E silicone varnish. These coils don't shrink or loosen at extremely high temperatures . . . last longer because they stay tight in the machine.

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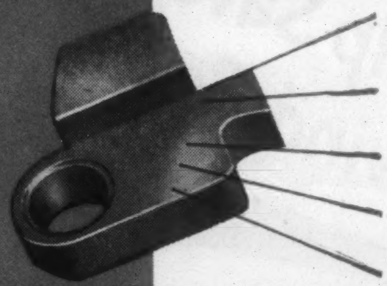

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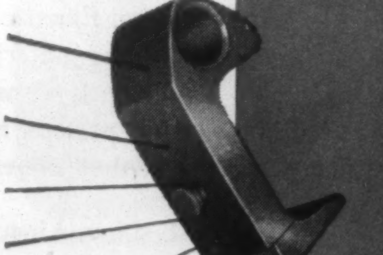

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News Digest

manufacture of chlorine and caustic soda at Montague, Mich., according to a recent company statement. The new plant is expected to be in operation by the end of 1953, with a yearly production rate of approximately 100,000 tons of all products.

Celanese Corp. of America has announced the sale of its Vimlite Dept. to the *Arvey Corp.*

A tract of more than 400 acres for industrial development has been assembled by *Hotpoint, Inc.* about 20 miles from the Chicago Loop as a final step in a 5-year expansion program announced in 1947. This will be the new site for the erection of a 1,000,000-sq-ft building as soon as defense restrictions will permit.

Greatly increased production has been made possible by a new unit process plant —part of a $3,000,000 expansion program —operating at the *J. T. Baker Chemical Co.* works in New Jersey. The plant will boost production of many inorganic chemicals used in atomic energy, steel, rubber and munitions.

Studebaker Corp. recently opened its Eastern Assembly plant in New Jersey. Built as an auto plant, the new plant will now manufacture component parts for jet engines for the Air Force.

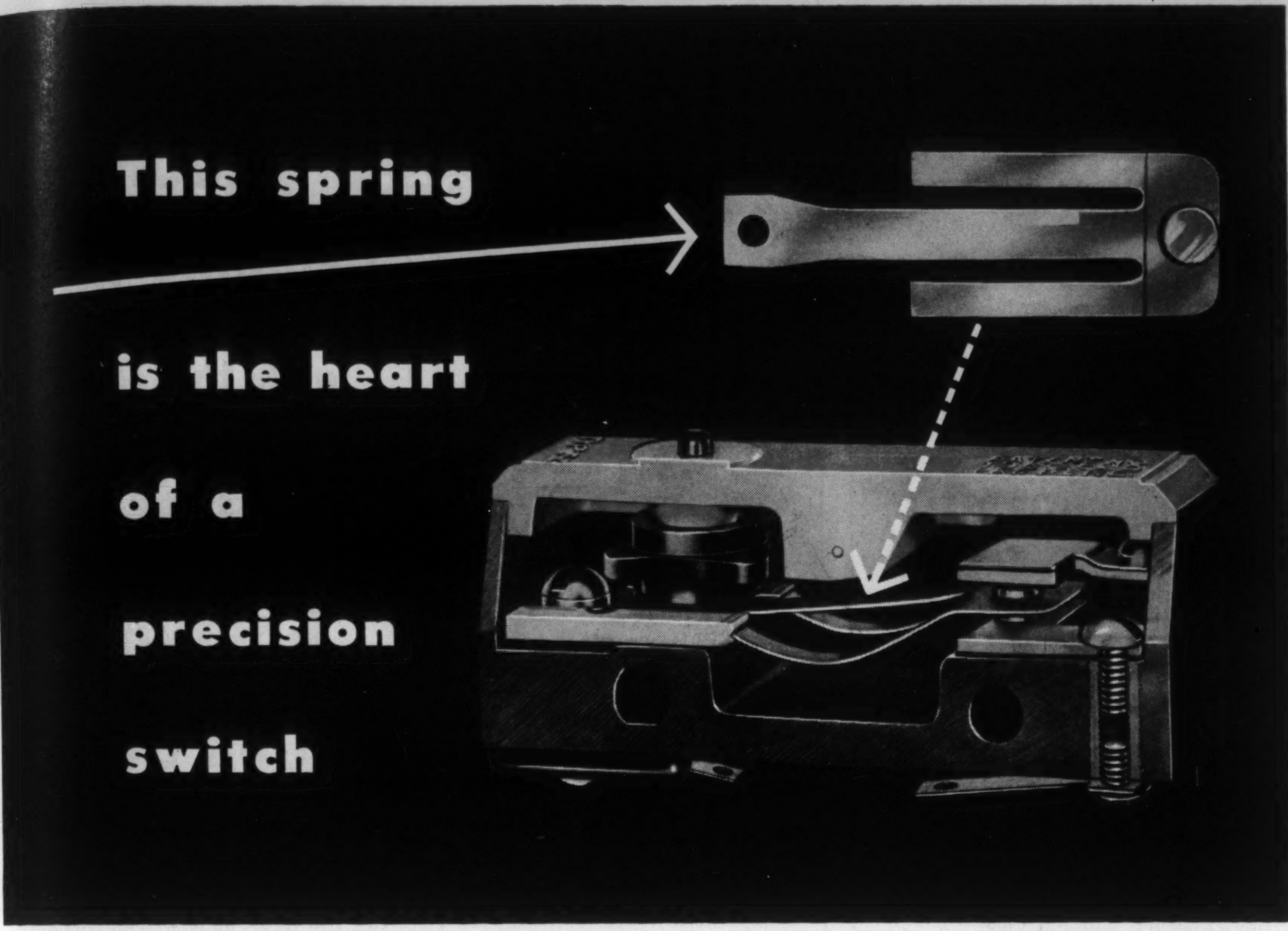
News of Societies

Announcement has been made by the *Resistance Welder Manufacturers Association* of their annual Prize Paper Contest, which offers a total of $2,250 in prizes for outstanding papers dealing with resistance welding subjects. The contest provides an opportunity to those in industry or engaged in research to compete for a first prize of $750, a second prize of $500, and a third prize of $250.

At its meeting in Philadelphia, the Board of Directors of the *American Society for Testing Materials* paid tribute to the *National Bureau of Standards* on the occasion of the Bureau's semicentennial. In accordance, a scroll was presented to NBS in recognition of its "invaluable contributions" to science, standards, public welfare and industry.

The appointment of J. Alfred Berger as acting head of the Dept. of Metallurgical Engineering, *University of Pittsburgh*, has been announced by the school.

J. F. Lincoln, president, The Lincoln Electric Co., was elected president of the *National Electrical Manufacturers Association* at the NEMA's 25th annual meeting. Five new vice presidents and a treasurer were also named.



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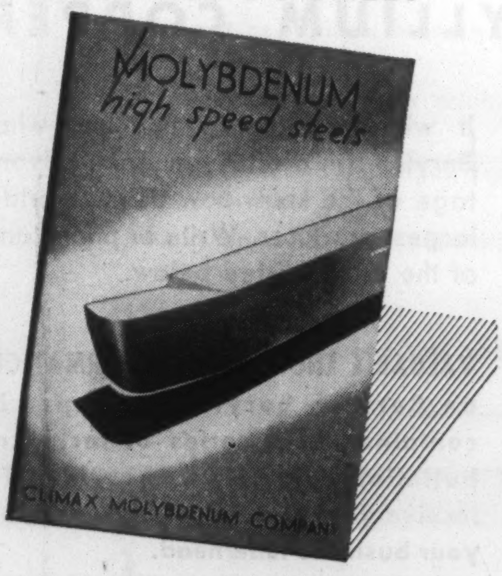

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Meetings and Expositions

PLANT MAINTENANCE SHOW AND CONFERENCE. Philadelphia. Jan. 14-17, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit. Jan. 14-18, 1952.

SOCIETY OF PLASTICS ENGINEERS, INC., national conference. Chicago. Jan. 16-18, 1952.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting. Cleveland. Jan. 18, 1952.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, winter general meeting. New York. Jan. 21-25, 1952.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. St. Louis. Jan. 28-30, 1952.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York. Jan. 28-Feb. 1, 1952.

AMERICAN SOCIETY FOR METALS, midwinter technical meeting. Pittsburgh. Jan. 31-Feb. 1, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York. Feb. 18-21, 1952.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting and committee week. Cleveland. Mar. 3-7, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, passenger car, body and materials meeting. Detroit. Mar. 4-6, 1952.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, spring meeting. Chicago. Mar. 10-13, 1952.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual conference. Galveston. Mar. 10-14, 1952.

SOCIETY OF THE PLASTICS INDUSTRY, national plastics exposition. Philadelphia. Mar. 11-14, 1952.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Chicago. Mar. 17-21, 1952.

STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting. Chicago. Mar. 18-19, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Seattle. Mar. 24-26, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace, Coke Oven & Raw Materials conference, Iron & Steel Div. Pittsburgh. Mar. 31-Apr. 2, 1952.

SOCIETY OF THE PLASTICS INDUSTRY, Reinforced Plastics Div. meeting. Chicago. Apr. 9-11, 1952.

SOCIETY OE AUTOMOTIVE ENGINEERS, national aeronautical meeting. New York. Apr. 21-24, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div., New England regional conference. Boston. Apr. 25-26, 1952.

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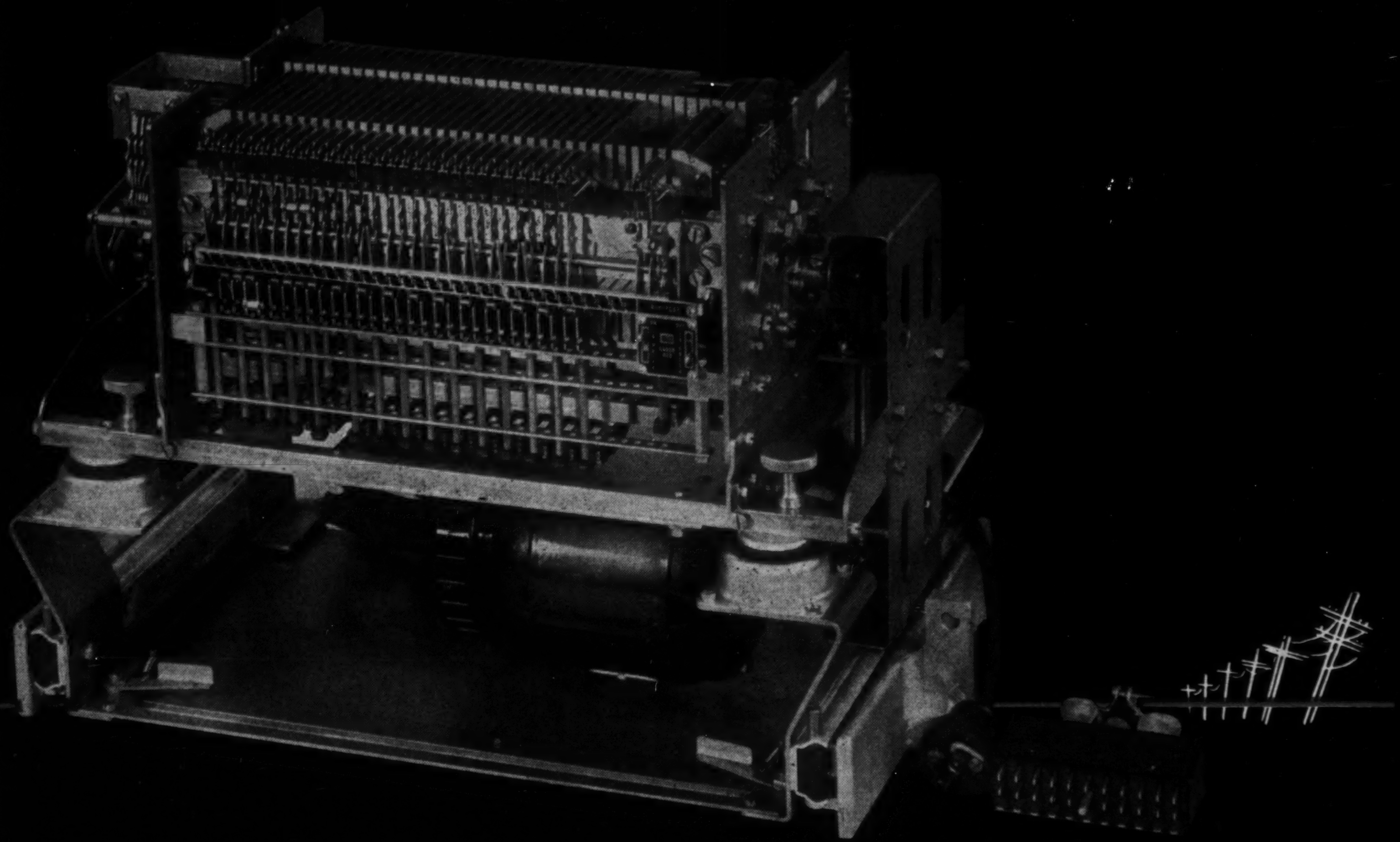

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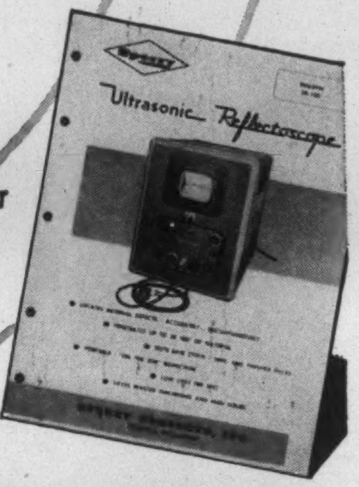

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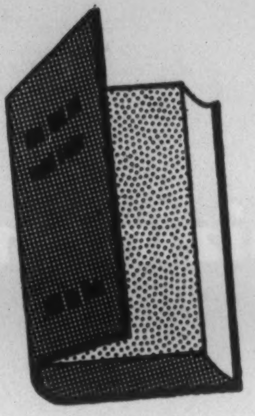

BOOK REVIEWS

Materials for Electron Tubes

MATERIALS TECHNOLOGY FOR ELECTRON TUBES. *By Walter H. Kohl. Published by Reinhold Publishing Corp., New York 18, N. Y., 1951. Cloth 6¼ by 9¼ in., 493 pages. Price $10.00.*

This book presents up-to-date information on materials used in the construction of electron tubes. It is the first one in English which aims at a thorough scientific treatment of the main solids that enter into the construction of electron tubes.

The treatment of materials, such as glass, ceramics, mica, tungsten, molybdenum, tantalum, copper, nickel and graphite is one feature of the book. Each chapter dealing with these metals contains an extensive tabulation of the physical characteristics and the chemical reactions taking place with various reagents. The description of processes used for the application of these materials is another feature.

Included is a critical review of the work done throughout the world by many research workers. Certain data and description of processes are published here for the first time. There is a review of atomic theory and the classification of crystals which provides a welcome introduction to the novice in this field. The tube engineer, development engineer, materials engineer and technician, in any field where these materials are being used, can get from the book the pertinent data required and, from the references, a quick guide to more extensive study of the literature.

The Properties and Handling of Dangerous Materials

HANDBOOK OF DANGEROUS MATERIALS. *By N. Irving Sax. Published by Reinhold Publishing Corp., New York 18, N. Y., 1951. Cloth, 7½ by 10¼ in., 848 pages. Price $15.00.*

This reference book, covering over 5,000 hazardous industrial materials, including

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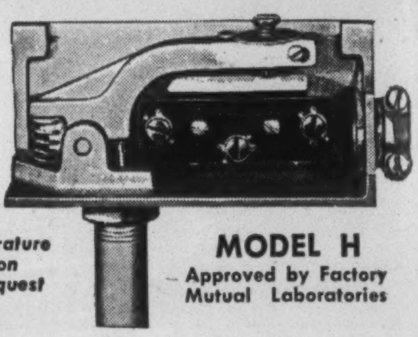
USE NO LIQUIDS . . . NO GASES

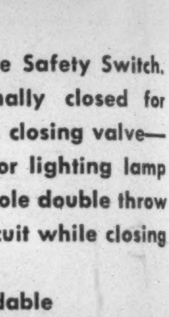


Literature on Request

MODEL H
Approved by Factory Mutual Laboratories

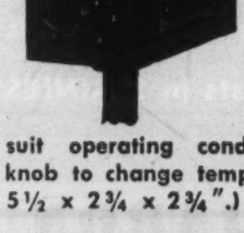
Improved High Temperature Safety Switch. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell—with single pole double throw switch . . . breaks heating circuit while closing alarm circuit.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting inside case
- Locking screw locks temperature setting.
- Terminal plate has large screw terminals
- Snap-action Micro-Switch eliminates contact troubles
- Range minus 100° to 1400° F. Adjustable range 200 degrees
- Dimensions—5⅛″ x 1¾″ x 3″



MODEL V-1

For lower temperature range from 0-300° F. Available for minimum of—100° to maximum of 600° F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾″ diameter × 4¼″ high.)



MODEL D

Adjustable range 200-500° F. Temperature range 0-1400° F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾″.)

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HY-TEN-SL
A Bronze as Strong as Nickel Steel

TRADE-MARK

Grade of HY-TEN-SL	1AA	1A	1	2	3	4
TENSION						
Ultimate tensile strength lbs. per sq. in.		(Minimums)				
Sand Cast	125,000	115,000	108,000	100,000	90,000	85,000
Rolled 1" and under	....	120,000	110,000	105,000	95,000	85,000
Rolled or Forged, over 1"	....	115,000	108,000	100,000	90,000	85,000
Yield Point (divider method)						
Sand Cast	95,000	75,000	60,000	55,000	45,000	40,000
Rolled 1" and under	....	75,000	65,000	60,000	50,000	45,000
Rolled or Forged, over 1"	....	75,000	65,000	60,000	50,000	45,000
Elongation in 2"—%						
Sand Cast	10	12	14	15	20	25
Forged or Rolled	....	12	13		15	20
Reduction in area—%						
Sand Cast	....	12	14	15	20	25
Forged or Rolled	....	12	13		15	20
COMPRESSION						
Yield Point— lbs. per sq. in.	70,000	65,000	58,000	50,000	40,000	35,000
Permanent Set at 100,000 lbs. per sq. in. (max.)	.015	.020	.030	.050	.080	.125
Brinell hardness, No.	250	240	220	200	175	150

List of U. S. Government Specifications Covering HY-TEN-SL Bronze

ARMY
Forgings, Rolled Rod QQ-B-721 Class B
Castings...QQ-B-726 Class B and C

NAVY
Forgings and Rolled Rod 46B15d Class B
Castings, Aluminum-manganese Bronze 46B29

WATERTOWN and OTHER ARMY ARSENALS
Castings WXS-5
Forgings and Rolled Rod......WXS-2
NAVAL GUN FACTORY
Washington Navy Yard
Castings—Trunnion Metal......O.S.550
AIRCRAFT
See Navy and Army (above).

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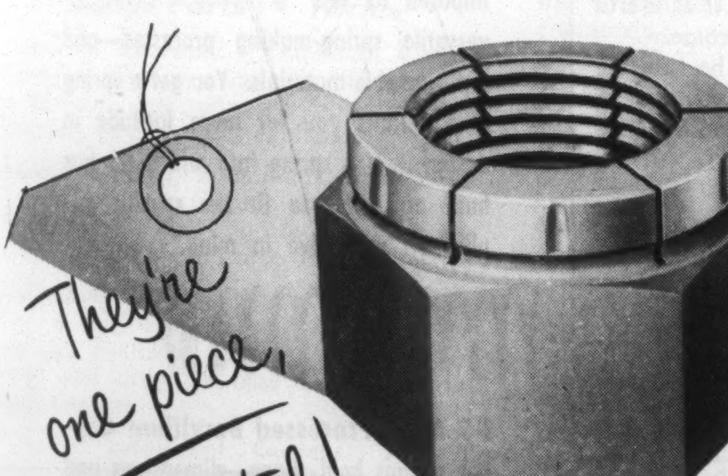
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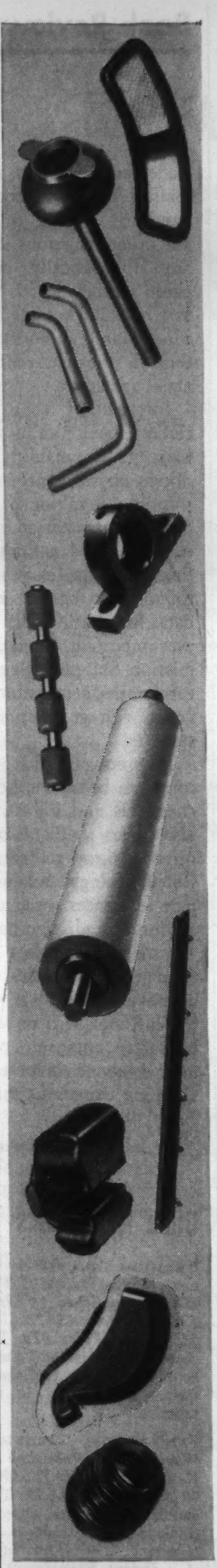

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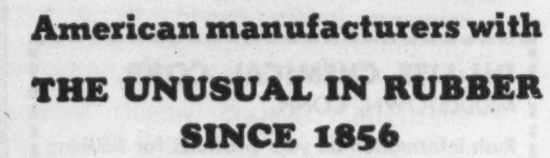

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Book Reviews

(continued)

trade-name products, offers valuable information to those concerned with safely handling, storing or shipping chemicals and other dangerous items. These materials are alphabetically arranged, cross-referenced and indexed. For the first time, this book makes readily available simple, concise and authoritative statements concerning the hazardous properties of so many materials.

Information about each material includes: maximum allowable concentration, toxicity, flammability, storage and handling, physical properties, formulas and shipping regulations. Wherever possible, detailed information is given on symptoms, treatment and antidotes, first aid suggestions, personnel safety precautions, fire extinguishing agents and other pertinent data. In addition, the complete text of the ever-important Interstate Commerce Commission Shipping Regulations is included for detailed instructions on labelling, packaging, storage, shipping and all relevant subjects.

Not only is this a most useful and complete book on the hazards of general chemicals and industrial materials, but it also covers the fields of explosives, fungus infections and radiation safety. For chemical toxicology and fungus hazards, up-to-date references are given in every case. The section on radiation hazards is said to give the most recent data available and many fundamental concepts, to make it as useful as possible for some time to come.

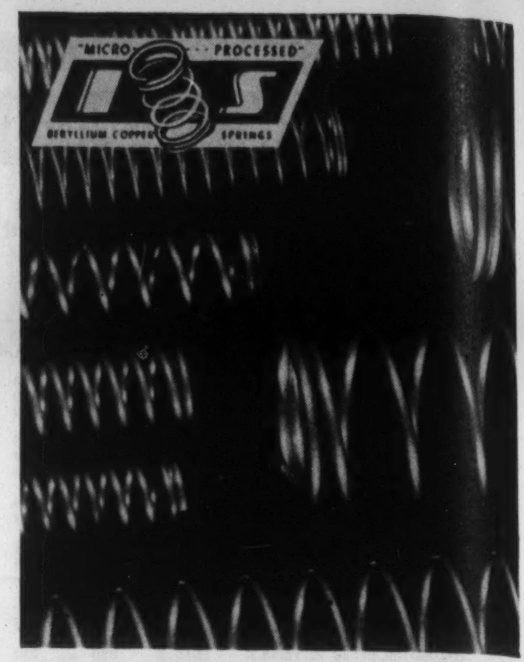
This book will undoubtedly be valuable to safety engineer, plant superintendent and everyone involved in handling and shipping dangerous materials.

Other New Books

CHEMICAL ANALYSIS OF CAST IRON AND FOUNDRY MATERIALS. *By W. Westwood and A. Mayer. Published by George Allen & Unwin Ltd., London, 1951. Cloth, 6¼ by 9½ in., 565 pages. Price 42s.* Intended for both the research chemist and the routine analyst, this book deals with the chemical analysis of all metals encountered in modern iron foundry practice.

PATENTS FOR TECHNICAL PERSONNEL. *By Worth Wade. Published by Chenomonics, Inc., New York 17, N. Y., 1951. Paper, 6 by 9 in., 40 pages. Price $3.00.* This concise, up-to-date handbook provides supervisory and technical employees and students of chemistry and engineering with information on the functions of a Patent Department, how to recognize an invention, how to keep proper records, how to protect inventions, how to read a patent, and the benefits to be derived by the employee and a company from inventions and patents.

QUALITY-CONTROL HANDBOOK. *Edited by J. M. Juran. Published by McGraw-Hill Book Co., New York 18, N. Y., 1951. Cloth, 6¼ by 9¼ in., 800 pages. Price $10.00.* A detailed reference book of industrial know-how on the fundamentals and means of achieving better quality at lower costs. It is designed primarily for reference and use by executives, supervisors and engineers in industry who need to locate promptly the specific answers to actual problems as they arise in the day's work.



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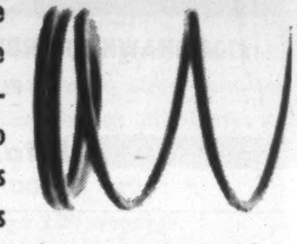

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specifications and prices of Vitreosil ware said to be superior to porcelain in some uses. (58)

Molded Thermoplastics. Tri-State Plastic Molding Co., Inc. Folder describes this company's facilities for producing to order thermoplastics parts by injection molding. (59)

Rubber Parts. Tyer Rubber Co., 4 pp, ill, No. 1c. Describes design and molding service for rubber parts, specified by industry. (60)

Inert Plastic. U. S. Gasket Co., Teflon Products Div., No. 300. Description and specifications of available stock of Teflon, chemically inert, electrically resistant plastic. (61)

Carbon-Graphite Parts. U. S. Graphite Co., 68 pp, ill, No. G-49. Properties, chemical resistance, limitations, assembly information, design aids and 60 applications of Graphitar. (62)

Polyvinyl Resins. U. S. Rubber Co., Naugatuck Chemical Div., 20 pp, ill. Properties, ingredients, compounding and processing of Marvinol polyvinyl chloride resins. (63)

Thermoplastic. Van Dorn Iron Works Co., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (64)

Industrial Plastic. Westinghouse Electric Corp., 36 pp, ill, No. B-3184-D. Data book on properties, grades, shapes and sizes, applications and machining of Micarta, a reinforced resin. (65)

Metal Parts • Forms

Aluminum Extrusions. Aluminum Co. of America. Design potentials of extrusion process and cost savings in fabrication and assembly of extrusions explained. (66)

Aluminum Parts. Aluminum Goods Mfg. Co., 56 pp, ill. Catalog covers extensive production facilities and technical services for producing wide range of parts. (67)

Prefinished Metals. American Nickeloid Co., 4 pp. Sampler shows finishes and platings available on zinc, steel, copper, brass and aluminum-base metals with actual samples. (68)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of alloys recommended as most adaptable for this process. (69)

Precision Castings. Atlantic Casting and Engineering Co., 721 Bloomfield Ave., Clifton, N. J. "Quality Precision Castings for Industry" explains advantages of plaster mold process, gives specifications on this firm's alloys. Request direct from Atlantic on company letterhead.

Aluminum Bronze Die Castings. Aurora Metal Co., 8 pp, ill. Description, advantages and sample products of firm's vacuum die casting process. Technical details of alloys used. (70)

Small Tubular Parts. The Bead Chain Mfg. Co. Describes Multi-Swage Process for economically custom producing small mechanical parts up to ¼-in. dia and 2-in. length. (71)

Steel Tubing. Bundy Tubing Co., 20 pp, ill. Properties, specifications and typical parts of Bundyweld double-walled, copper-coated steel tubing. (72)

Brass Wire Cloth. Chase Brass & Copper Co. Lists mesh, diameter of wire, percent open area, weight and other data on complete line of company's brass and copper wire cloth. (73)

Stainless Valves. The Cooper Alloy Foundry Co., 48 pp, ill. Catalog gives complete line of firm's stainless valves, fittings and accessories. Includes design information. (74)

Metal Stampings. Dayton Rogers Mfg. Co., 4 pp, ill. Describes low cost process for producing metal stampings in small lots. Shows costs of several example jobs. (75)

Stamped Parts. Detroit Stamping Co., 4 pp, ill. Pictures various examples of stamped parts, indicating the advantages, features and limitations of fabrication by stamping. (76)

Perforated Metals. Diamond Mfg. Co., 24 pp, ill, No. 35. Uses, advantages and specifications of various types of perforated metals. (77)

Magnesium Forms. Dow Chemical Co., Magnesium Div. Technical information on magnesium, its available forms and applications. (78)

Forgings. Drop Forging Association, 60 pp, ill. Data book shows mechanical qualities of forgings, and illustrates economic, engineering and production advantages available. (79)

Centrifugal Cast Pipe. The Duraloy Co., No. 3150. Bulletin shows this company's facilities for producing centrifugal cast pipe and tubing. (80)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries, "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (81)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. GI37. Describes facilities for economical manufacture of quality die castings. (82)

Corrosion Resistant Castings. Electro-Alloys Div., American Brake Shoe Co., No. T-171. Properties and engineering uses of Chemalloy corrosion-resistant alloys for casting. (83)

Enamelled Metal Strip. Enamelstrip Corp., 4 pp, ill. Describes coiled enamelled metal strip supplied in widths up to 30 in. which can be put through forming operation without damaging the coating. (84)

Flexible Tubing. Flexible Tubing Corp., 8 pp, ill, No. 5-4. Applications and performance data on Spiratube flexible tubing for ventilation and material conveying. (85)

Laminated Metals. General Plate Div., Metals & Controls Corp., 4 pp, ill, No. 1a. Properties and uses of various laminated metals including precision metal overlays and laminated silver contacts. (86)

Steel Tubing. Globe Steel Tubes Co., 8 pp, ill, No. 1a/12. Specifications and tolerances of Gloweld-welded seamless tube and pipe of Globe-iron and steel. (87)

Investment Castings. Gray-Syracuse, Inc., 4 pp. ill. Various parts of precision-cast brass, bronze, beryllium copper and steel. (88)

Double Headed Parts. John Hassall, Inc. Catalog shows numerous double headed parts, indicating applications and suggesting other applications of double heading operations. (89)

Beryllium Copper Electrical Parts. Instrument Specialties Co., Inc., 4 pp, ill, Nos. B-52, C-52. Specifications, descriptions and dimensions of beryllium copper grounding strips and contact rings. (90)

Investment Castings. Investment Casting Co., folder. Advantages and capabilities of this company's facilities for producing investment castings to customer's specifications. (91)

Precision Die Castings. The Jelrus Co., Inc., 4 pp, ill. Illustrates cost savings in parts production through use of nonferrous precision die casting methods. (92)

Powdered Metal Parts. Keystone Carbon Co., Inc., 36 pp, ill. Describes successful applications of powder metallurgy, gives data on correct design of powdered metal parts, and detailed information on powdered metal bearings. (93)

Aluminum Extruded Shapes. Light Metals Corp., 6 pp, ill. Shows facilities for producing to order a variety of indicated aluminum fabrications and extruded shapes. (94)

Die Castings. Litemetal DiCast, Inc., 12 pp, ill. How to select best light metal for die casting. Shows facilities producing light metal pressure die castings. (95)

Magnesium Parts. Magnesium Products of Milwaukee, 4 pp, ill. Briefly describes facilities for designing and producing to order magnesium and aluminum parts. Shows several products. (96)

Welded Assemblies. The R. C. Mahon Co., 1 p, ill. Shows several examples illustrating the capabilities of welding for construction of various assemblies. (97)

Controlled Quality Castings. Meehanite Metal Corp., 8 pp, ill, No. 31. Engineering data on casting plus specific applications showing capabilities of Meehanite gray iron castings. (98)

Precision Cast Products. Microcast Div., Austenal Laboratories, Inc., 9 pp, ill. Shows numerous precision cast parts indicating versatility of process for producing intricate parts. (99)

Precision Investment Castings. Midwest Foundry Co., 4 pp, ill. Typical examples of precision investment cast parts made from stainless steels, their advantages and potentialities. (100)

Plastic Coated Metal Tubing. Samuel Moore & Co., 4 pp, ill, No. F-2008. Describes properties, fabrication, available

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forms and fittings of Dekoron, plastic coated metal tubing with numerous uses. (101)

Forged Brass Parts. Mueller Brass Co., 5 pp, ill. Lower cost, better machinability are among advantages stated for forgings over sand castings used for hardware. (102)

Powdered Metals. The New Jersey Zinc Co., 4 pp, ill, Vol. 3, No. 1. *Metal Powder Press* shows numerous ways in which metal powders are being used to cut fabrication costs of metal parts. (103)

Precious Metal Parts. The J. M. Ney Co., 19 pp, ill, No. R-12. Properties, recommended uses and specifications of available types of precious metal alloys for sliding electrical contacts. (104)

Precision Casting. Ohio Precision Castings, Inc., 12 pp, ill. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium copper plaster mold castings. (105)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, ill. Describes Phoenixspun method for spinning spherical and extra deep-drawn contours. (106)

Metal Powders. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy as used by this firm for custom-making parts. (107)

Powder Metal Parts. Powdered Metal Products Corp. of America. Booklet shows advantages of powder metallurgy in manufacture of such parts as gears, sprockets and valves. (108)

Powdered Metal Parts. Radio Cores, Inc., 4 pp, ill. Describes this company's facilities for production of made-to-order powder metal parts of all types. (109)

Bushings. Randall Graphite Bearings, Inc., 12 pp, ill, No. 100. Complete price list of bronze bushings and specially grooved bushings; specifications of bored and solid bronze bars. (110)

Condenser Tubes. Revere Copper and Brass Inc., 28 pp, ill. Detailed discussion of ways to make condenser tubes last longer, what they are made of and new developments in materials. (111)

Aluminum Forging Stock. Reynolds Metals Co., 4 pp, ill, No. AD 400-15-650. Technical data in tabular form, including mechanical properties and alloys and tempers of aluminum wire, rod, bar and forging stock. (112)

Rigidized Metal. Rigidized Metals Corp., 8 pp, ill, No. CF1. Shows advantages of using rigidized stainless sheet metals in place of other sheet. Shows several available patterns, indicates many uses. (113)

Steel Wire Rope. John A. Roebling's Sons Co., folder, ill. Describes the manufacture of steel wire rope from the manufacture of the steel through to the finished rope. (114)

Stainless Tubing. The Standard Tube Co., 4 pp, ill. Suggests numerous uses for welded stainless tubing and gives range of available sizes and shapes. (115)

Powder Metal Parts. F. J. Stokes Machine Co., 4 pp, ill, *Stokes News*, Vol. 3, No. 3. Indicates some diverse applications of powder metal parts made by this firm. (116)

Spun Metal Parts. Roland Teiner Co., Inc., 4 pp, ill. Describes facilities for spinning metal parts for all types of metal, including stainless steels. (117)

Aluminum Bonded to Steel. Arthur Tickle Engineering Works, 8 pp, ill. Describes process for molecular bonding of aluminum to iron and steel, its applications and advantages. (118)

Stainless Tubing. Trent Tube Co. *Trentweld Data Bulletin* describes Trentweld stainless steel tubing, machine formed and welded in wide range of sizes. (119)

Compression-Formed Tubing. Tube Reducing Corp., 8 pp, ill, No. R-3. Specifications, description and method of making steel compression-formed tubing described. (120)

Coatings • Finishes

Zinc, Cadmium Finishes. Allied Research Products Inc. Describes Iridite finishes for zinc and cadmium in chromium-like, olive green, iridescent and other colors. (121)

Protective Coating for Aluminum. American Chemical Paint Co., 4 pp, ill, No. 586B. Describes application, characteristics and advantages of "Alodine" phosphate coatings for aluminum. (122)

Metal Coatings. The Dampney Co. of America, 6 pp, No. 1550. Describes features, methods of application and specifications of this company's vinyl resin metal primer Apexior No. 3. (123)

Tough, One-Coat Finish. Ferro Enamel Corp., Liquid Plastic Div., 4 pp. Properties and advantages of Hammeroc synthetic alkyd enamel said to be resistant to soap, alkalis and moisture. (124)

Hot-Spray Lacquer. Hercules Powder Co., 12 pp, ill, No. 500-131-A. Describes typical uses of hot-spray lacquers, the advantages derived, disadvantages and predictions of increased use. (125)

Protective Coatings. R. M. Hollingshead Corp., ill. Folder describes Klad Kote corrosion preventives, gives detailed specifications, uses, description and other data in tabular form. (126)

Clear Lacquer. Maas & Waldstein Co., No. 110. Recommends Dulac Clear Universal Lacquer No. 462 for good adherence and retention of desirable surface qualities. (127)

Metallizing. Metallizing Co. of America 20 pp, ill. Describes metallizing process and its usefulness in fighting corrosion, rebuilding worn parts, and reclaiming mis-machined castings. (128)

Abrasion Resistant Coating. Minnesota Mining & Mfg. Co., Adhesives and Coatings Div., 4 pp, ill, No. Z-CSB. Details on EC-968, tough, abrasion resistant coating for polished metals. (129)

Zinc Dust Paints. New Jersey Zinc Co., 36 pp, ill. Characteristics and uses of zinc dust paints, most adherent paints for galvanized iron and steel zinc. (130)

Black Oxide Finishing. Oakite Products, Inc., 4 pp. Technical data on materials and methods for cleaning and preparing metals for black oxide finishes. (131)

Phosphate Coating. Octagon Process Inc., 8 pp, ill. Describes Anchorite 100 phosphatizing compound for corrosion protection and paint bonding. Describes application methods and shows many uses. (132)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 211.

Methods and Equipment

Heat Treating • Heating

Heat Treating. Ajax Electric Co., Inc., 72 pp, No. 116. Detailed data on various methods of heat treating metals in this firm's salt bath furnaces. Request direct from Ajax on company stationery.

Induction Furnaces. Ajax Electrothermic Corp., 8 pp, ill, No. 27A. Advantages and applications of, and equipment for induction heating and melting. Includes selector chart for induction heating and melting. (133)

Induction Furnaces. Ajax Engineering Corp. Information on Ajax-Tama-Wyatt induction furnaces for melting metals with accurate temperature control and freedom from contamination. (134)

Continuous Quenching Tanks. American Gas Furnace Co., 4 pp, ill, No. 820. Specifications of complete line of continuous automatic quenching tanks. Shows several factory installations. (135)

Refractories. The Carborundum Co., 20 pp, ill, No. 5120. Describes Super Refractories, the temperatures they withstand, their other properties making them useful as furnace linings. (136)

Heat Treating Slide Indicator. Carpenter Steel Co. Indicates heat treatments recommended for various tool and die steels and effects of drawing temperature on hardness. (137)

Controlled Atmosphere Furnace. Dow Furnace Co., 4 pp, ill. Data on batch-type controlled atmosphere furnaces for gas cyaniding, carburizing and other similar

MANUFACTURERS' LITERATURE

operations. (138)

Electrical Sintering Furnaces. Harper Electric Furnace Corp., 2 pp, ill, No. 847. Construction features, operation and specifications of sintering furnaces for powder metals. (139)

High Pressure Oil Burners. Hauck Mfg. Co., No. 456. Descriptions and specifications of high pressure atomizing oil burners. (140)

Electric Heat Treating Furnaces. Hevi Duty Electric Co. Guide to periodic inspection of electric furnaces outlines each step to be taken in a preventative maintenance program. (141)

Pot Furnaces. The A. F. Holden Co., 19 pp, ill. Principles, features and advantages of this company's four types of pot furnaces for heat treating at temperatures up to 2350 F. (142)

Heat Treating Defense Equipment. E. F. Houghton & Co., 50 pp, ill. Technical data on heat treating and metal working operations invloved in producing shells rockets, guns and other defense items. (143)

Heat Treating Furnaces. Ipsen Industries, Inc., 6 pp, ill. Diagrammatic description of operating principle of Ipsen Series "T" Heat Treating Unit. Includes specifications and applications. (144)

Insulating Blocks. Johns-Manville Corp., 4 pp, ill, No. IN. 134A. Economic advantages, properties and examples of available shapes of Superex high temperature insulating blocks. (145)

Induction Heating for Brazing. Lepel High Frequency Laboratories, Inc., 8 pp, ill. Details on induction heating units for accelerated brazing of parts. (146)

High Frequency Heater. Lewis Machine Co., Inc., 4 pp, ill. Description, specifications and advantages of this company's induction unit for production brazing, hardening and annealing. (147)

Atmosphere Generators. Lindberg Engineering Co., 12 pp, ill, No. 190. Principles of this company's atmosphere generators, their applications, the compositions of the atmospheres generated, and the anticipated costs. (148)

Low Frequency Induction Heating. Loftus Engineering Corp., 4 pp, ill. Description, operating characteristics and advantages of this company's 60-cycle induction heating apparatus. (149)

Induction Heating Furnace. Magnathermic Corp., 6 pp, ill. Features, applications and description of this company's low frequency heating furnaces, claimed to be well-suited to extrusion processes. (150)

Refractory Cements. Norton Co., ill, No. 863. Describes this company's refractory cements, their applications and properties. (151)

Furnace Treatment of Steels. Republic Steel Corp., 13 pp, ill, No. ADV-452. Discussion of various types of furnaces used in heating steels, their principles and chief uses, and brief explanations of various heat treatments. (152)

Heat Treating Equipment. W. S. Rockwell Co. Catalog of this company's batch- and continuous-type furnaces, ovens, and strip and wire mill equipment. (153)

Conveyor Furnace. Sargeant & Wilbur, Inc., ill. Features specifications and advantages of this firm's conveyor furnace for bright brazing, hardening and annealing of stainless steel. (154)

Heat Treating Furnaces. Standard American Engineering Co., 6 pp, ill. Principle of Radivection gas fired furnaces, indicating advantages in more uniform, faster heating for heat treating purposes. (155)

Heat Treating Accessories. Stanwood Corp., 16 pp, ill, No. 16. Describes variety of heat treating accessories, including baskets, retorts and carburizing boxes. (156)

Induction Heaters. Westinghouse Electric Corp., 12 pp, ill, No. B-4782. Case histories showing applications, advantages and versatility of this company's equipment for induction heating. (157)

Radiant Heaters. Edwin L. Wiegand Co., 29 pp, ill, No. FM-2060. Case histories of Chromalox electric radiant heaters with wide assortment of uses. (158)

Cleaning • Finishing

Belt Grinders and Finishes. Behr-Manning. Bulletin describes advantages of belt finishing and grinding, shows this company's equipment, and suggests methods for cost cutting. (159)

Plating Tanks. The Chemical Corp., 4 pp, ill. Data sheets on chemical resistance of resin-bonded Fiberglas plating tanks, their specifications and advantages. (160)

Electrocleaning Process. The Diversey Corp. Describes Diversey No. 909 and No. 12 components of economical electrocleaning process eliminating solvent and handwipe operations. (161)

Diamond Abrasive. Elgin National Watch Co., 8 pp, ill, No. 5000651. Features, advantages and helpful data for selection of Elgin Dymo-C diamond abrasives. (162)

Power Driven Brushes. The Fuller Brush Co., 32 pp, ill. Describes Fullergript brushes, their application to such processes as scrubbing steel sheet and tampico brushing. (163)

New Equipment for Coating. The Gyromat Corp., 4 pp, ill. Describes Norris Gyromat, centrifugal spraying machine said to apply standard industrial coatings and finishes faster, more economically. (164)

Barrel Finishing Media. Newton Industries Inc., 4 pp, ill. Describes advantages of Polishapes, zinc alloy bodies specially designed for use in barrel finishing processes. (165)

Metal Cleaning. Northwest Chemical Co., 2 pp. Describes "Lo-Hi" two-tank process for the preparation of metals for plating and vitreous enameling. (166)

Liquid Blast Cleaning Equipment. Pangborn Corp. Features, specifications and applications of this company's equipment for finishing of molds, dies, tools and other parts. (167)

Cleaners for Ferrous Metals. Pennsylvania Salt Mfg. Co., 8 pp, ill, No. S-560. Describes recommended Pennsalt alkaline cleaners for such methods as soak tank, spray and electrolytic cleaning. (168)

Metal Cleaner. Philadelphia Quartz Co., ill., No. 33-4. Describes Metso 66 soluble silica heavy duty alkali metal cleaner with brief recommendations for use. (169)

Vapor Degreasing Equipment. Phillips Mfg. Co., 21 pp, ill. Handbook gives a detailed description of vapor degreasing process, the materials used, its applications, advantages and limitations. (170)

Mechanical Finishing. Roto-Finish Co. Folder describes uses and economies of Roto-Finish tumbling-type equipment for precision grinding, deburring and coloring metals. (171)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (172)

Welding • Joining

Welding Electrodes. Alloy Rods Co., 12 pp, ill, No. AR51-1. Brief discussions of various uses of this company's alloy welding electrodes in defense applications. (173)

Resin Adhesive. American Cyanamid Co., 8 pp, ill. Discusses stability and bonding properties of Urac 180 Resin Adhesive. Uses for cold and hot plywood pressing and wood bonding indicated. (174)

Silver Brazing Alloy. American Platinum Works. Physical characteristics and uses of A.P.W. No. 355 silver brazing alloy, closely matching stainless steel in color. (175)

Bonding Resins. Ciba Co., 4 pp, ill. Properties of new group of resins, their applications as adhesives for metals and nonmetallics, moldings and coatings. (176)

Welding. Eutectic Welding Alloys Corp., 43 pp, ill, No. 1. Data on various welding processes, joining methods and techniques, applications; describes Eutectic Low Melting Alloys. (177)

Welding Electrodes. General Electric Co., Apparatus Dept., No. GEC-482. Pocket-sized catalog gives complete line of G-E welding electrodes for all purposes. (178)

Versatile Adhesives. B. F. Goodrich Co., 8 pp, ill, No. 1-7847-NS. Specifications, compositions, properties and directions for using. Plastilock adhesives for bonding such materials as metal to metal, wood to metal. (179)

Brazing Preforms. Handy & Harman, No. 54. *Brazing News* describes use of preforms to assure soundly brazed parts. (180)

Fastener. Huck Mfg. Co., 5 pp, ill. Description and specifications of Huck Lockbolts, new high shear strength fasteners incorporating principles of rivets and bolts. (181)

Brass and Bronze Fasteners. The Jacques Co., 26 pp, ill, No. 50. Price lists and specifications of this firm's fasteners, including various nuts, cap screws, bolts and washers. (182)

Solders. Kester Solder Co., 28 pp, ill.

MANUFACTURERS' LITERATURE

Complete analysis of properties and applications of a variety of Flux Core soft solder alloys and soldering fluxes. (183)

Brazing Rings. Lucas-Milhaupt Engineering Co., ill. Case history shows advantages of patented, notched-coil, stress-relieved silver alloy brazing and soldering rings. (184)

Stainless Steel Electrodes. The McKay Co., 48 pp. Data on arc welding of stainless steels giving specific uses of alloying elements and specifications of each type of McKay stainless steel electrode. (185)

Self-Locking Fasteners. The Palnut Co., 1 p, ill. Describes self-locking machine screw Palnuts, coil tube fasteners, shield can fasteners and acorn Palnuts. (186)

Welding Positioners. Ransome Machinery Co., Industrial Div., 36 pp, ill, No. 210 C. Description, features and applications of 100- to 40,000-lb capacity welding positioners. (187)

Self-Locking Nuts. Shakeproof, Inc., 6 pp, ill, No. 1. Illustrates seven applications of Keps pre-assembled nuts and lockwashers to otherwise difficult bolted assemblies. (188)

Fasteners. Simmons Fastener Corp. Literature describes fasteners especially designed for use in construction where easy demountability is required (189)

Carbon Arc Welding. Speer Carbon Co., 8 pp, ill. Advantages of carbon arc welding for fabricating and repairing alloy and nonferrous metals. (190)

Forming • Casting • Molding • Machining

Zinc Alloy Dies. Allied Products Corp., Richard Bros. Div., 4 pp, ill, No. W-35-950. Describes Allite zinc alloy dies for temporary production to test new forms, while repairing permanent dies. (191)

Compacting Presses. Baldwin-Lima-Hamilton Corp., 4 pp, ill, No. 323. Features, advantages and specifications of this company's compacting presses for plastics, ceramics and powder metals. (192)

Metal Fabrication. Geuder, Paeschke & Frey Co., 12 pp, ill. Shows this company's facilities for fabricating and coating sheet metals for military production to customer's specifications. (193)

Metal Marking Equipment. Green Instrument Co., 4 pp, ill. Features and applications of various types of engraving and metal marking machinery, including pantograph engraver for tracing designs. (194)

Mold Heating Units. Improved Paper Machinery Corp., Plastic Molding Machinery Div., 1 p, ill. Specifications and descriptions of Models 1 and 2 mold heating and circulating units. (195)

Grinders. The McGonegal Mfg. Co., 24 pp, ill. Features, construction details, mounting types and specifications of various models of grinding wheels of this company. (196)

Multiple Hole Punching. Wales-Strippit Corp., 8 pp, ill. Features, applications, parts and typical setups of multiple hole punching systems for rapidly punching sheet parts. (197)

Metal Forming Facilities. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (198)

Magnetic Perforating Dies. S. B. Whistler & Sons, Inc., ill. Complete descriptions and applications of this company's magnetic perforating dies. (199)

Inspection • Testing • Control

Contour Measuring Projector. Bausch & Lomb Optical Co., No. D-27. Specifications and features of contour measuring projector claimed to enable very accurate measurements of parts. (200)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (201)

Ultrasonic Tester. The Brush Development Co., 4 pp, ill. Operating principle and uses of the "Hypersonic" Analyser for nondestructive inspection of materials. (202)

Magnifying Contour Projector. Eastman Kodak Co., 8 pp, ill, No. F1-23. Operating principle, applications, features, specifications and accessories of this firm's contour projector. (203)

Radium Radiography. Eldorado Mining & Refining (1944), Ltd., P. O. Box 379, Ottawa, Canada, 71 pp, ill, price $2.00. Detailed theory, equipment and applications of radium radiography. Available directly from Eldorado.

Jaws for Tensile Testers. Instron Engineering Corp., 2 pp, ill. Features, advantages and specifications of various models of jaws for gripping tensile test specimens in tensile testing machines. (204)

Repeated Stress Testing Machines. Krouse Testing Machine Co., 8 pp, ill, No. 46-C. Detailed description of repeated stress testing machines and accessories. Includes specifications. (205)

Nondestructive Testing Machine. Magnaflux Corp., 4 pp, ill, No. 16,001. Operating principle, advantages and applications of Duovec magnetic particle testing machines. (206)

Measurement Recorders. Minneapolis-Honeywell Regulator Co., 2 pp, ill, No. 10.0-6. Operating principles, features and applications of recording machine suited to recording two independent variables at once. (207)

Compression Tester. National Forge and Ordnance Co., 2 pp, ill, No. 492. Description, features and uses of sensitive, sturdy, low-capacity-compression-crust testing machine. (208)

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 211.

Spectrographs. National Spectrographic Laboratories, Inc., 4 pp, ill, No. 300. Description, operating principle and control features of spectrograph units for both quantitative and qualitative analysis. (209)

Portable Hardness Tester. Newage International, Inc., No. ET209. Describes Ernst portable hardness tester for rapid, direct hardness readings in Brinell and Rockwell scales. (210)

Testing Machines. Tinius Olsen Testing Machine Co., 8 pp, ill, Vol. 5, No. 1. *Tinius Talks* describes various testing machines, their features, applications and advantages; discusses testing techniques. (211)

Materials Controls. Remington Rand Inc., No. KD367. Booklet describes Kardex system for keeping visible materials and parts inventories coordinated with production. (212)

Testing Services. Sperry Products, Inc., 8 pp, ill, No. 50-115. Shows typical tests on materials carried out by this firm's engineers for a great variety of companies using Reflectoscope and Reflectogage. (213)

Universal Testing Machine. Steel City Testing Machines, Inc., 2 pp, ill. Features of Model MP-10 machine for tensile transverse and compression testing up to 60,000-lb capacity. (214)

Thermocouples. Thermo Electric Co., Inc. Catalog Section 22G shows this firm's line of thermocouples and accessories for numerous industrial uses. (215)

Hardness Tester. Topflight Tool Co., Inc., 4 pp, ill. Features, operating instructions and parts list for this company's automatic certifying hardness tester. (216)

Plastics Tests. U. S. Testing Co., Inc., 2 pp. Price list of physical, chemical, microbiological and permanence tests available for plastics film, sheeting and coated fabrics. (217)

General

Molybdenum Disulfide Lubricant. Climax Molybdenum Co., 55 pp, ill. Excerpts from technical papers on molybdenum disulfide as a lubricant under various circumstances. (218)

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (219)

Threaded Inserts. Heli-Coil Corp., 15 pp, ill, No. 650-R. Description, advantages and specifications of Heli-Coil threaded inserts for insertion into tapped holes to protect threads, reduce wear and expense. (220)

Air Handling Equipment. The Spencer Turbine Co., No. 107-C. Data book on this company's equipment for the handling and use of compressed air. (221)